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INFORMATION SYSTEMS IMPLICATIONS OF IBM SOFTWARE STRATEGIES

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INFORMATION SYSTEMS IMPLICATIONS OF IBM SOFTWARE STRATEGIES

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I INTRODUCTION

A. BACKGROUND

- The task of defining IBM software directions in today's environment could be broken down into an infinite series of reports, and it is doubtful that any one of them would have more meaning than whatever was IBM's most recent software announcement. This was clearly pointed out by one INPUT client, who stated: "We need a mosaic so we can make some sense out of the individual pieces." Confronted with an endless series of announcements, rumors, and detailed analyses of specific systems, subsystems, and products, INPUT was already familiar with this requirement; it occurred to INPUT that IBM management could probably also use such a mosaic.

- The first step in constructing a mosaic is to move backwards; that is, it is necessary to get far enough away from the individual pieces to get some view of the whole. In stepping backwards, it was fortuitous that the report was being prepared on the twentieth anniversary of IBM's announcement of System/360. It was decided to stand far enough away from today's problems to look back twenty years, and this provided INPUT with enough distance to determine that one should look twenty years into the future. Therefore, the mosaic will be ~~forty~~ 40 years in length.

- With such an imposing length, it was decided that the depth should be in proper proportion, and thus this report covers: SNA, operating systems, data

base systems, languages and decision support systems, industry turnkey systems, applications packages, and data/information/knowledge bases (as products). The purpose is to recognize patterns and to provide a framework for detail.

- The following methodology was employed:

  - Past INPUT research was reviewed. Most of it was associated with specific pieces of the mosaic and represented specific points on the time scale. (These pieces, however, were extremely valuable as reference points.)

  - Comprehensive research was conducted on the history of software development from the 1950s to the present time. This research ranged from the historical files of an INPUT consultant to the Computer Science and Engineering Research Study (COSERS) sponsored by the National Science Foundation and published by MIT Press under the title What Can Be Automated. This research helped to establish structure for the subject areas, historical perspective on one half of the mosaic, a general view of the current state of the art, and an idea of what might be expected in the future.

  - Telephone interviews with a number of functional experts (past and present) were conducted from the inception of the project to the final editing. This was necessary both for checking detail and for retaining perspective.

  - A number of interviews were conducted with IBM personnel (and ex-IBM personnel) to explain the scope of the project and to obtain insight into the historical foundation of current IBM software systems, current issues of importance, and possible future directions of software technology (using INPUT's broad definitions).

- o At this point, the historical half of the mosaic was completed, but the future was only partially clear. The approach taken was to start with what is known about IBM's future direction. This was simple; the only thing known about IBM's direction is that it incorporates a strategic plan that will attempt to maintain its past growth. It was then necessary to determine how IBM might achieve these growth objectives, and to ascertain the part software must play in overall strategy.

  - For this purpose, four strategic periods were carefully defined, based on INPUT-developed technological scenarios. Each strategic period was then analyzed in terms of IBM dependencies and challenges during the period; probable opportunities for software products and services were projected.

  - Furthermore, patterns began to emerge from the research, but these patterns did not necessarily help in determining IBM's software direction. There was no language to describe direction: up, down, backwards, and forward had no meaning. It was decided to apply the concepts of general systems theory (GST) to IBM's software directions, and it was determined that directions could be established relative to what is probable (or inevitable), considering the current state of hardware/software technology. These GST concepts are: Progressive Centralization, Progressive Integration, Progressive Differentiation, and Progressive Mechanization. These concepts will be described in the body of the report and will be capitalized for emphasis.

- o Because the methodology evolved during the course of the study was being applied at a macro level, specific events that occurred during the preparation of this report were examined as a rough validation of the methodology. These analyses led to the conclusion that such events could be described using GST concepts and could be conveniently related to the strategic periods that had been defined. This rough validation also led to the conclusion that the methodology developed could be refined to facilitate both product analysis and forecasting.

B. THE KEY ROLE OF STRATEGIC PERIODS

- There has been a trend over the past 20 years away from mainframe-batch and toward interactive terminals, minicomputers, and microprocessors. This has generally been referred to as distributed data processing. It will continue. IBM's strategy has been to control this trend.

- What once had been called data processing system became management information systems and then decision support systems; now the term expert systems is coming into use. The primary difference between the systems to date has been the terminology. IBM supports the change in terminology.

- Over time it has been recognized that you can have data without information, and it will soon be recognized that you can have information without knowledge. Data, information, and knowledge bases are all becoming necessary. There are indications that IBM understands the significance of this trend.

- While it was originally much maligned, IBM systems software has become a standard. Subsystems and applications systems compatible with IBM's network architecture and operating systems have lessened direct competition with IBM, and increased synergism of purpose has developed since IBM actively seeks outside software. IBM will develop into the biggest single market for software.

- IBM software directions are complex and difficult to describe. This study employs the General Systems Theory (GST) concepts of Progressive Centralization, Progressive Integration, Progressive Differentiation, and Progressive Mechanization to describe IBM directions and to isolate opportunities. While all these trends proceed in parallel, emphasis shifts over time.

II

II EXECUTIVE SUMMARY

- This Executive Summary is designed in a presentation format in order to:
  - Help the busy reader quickly review key research findings.
  - Provide ready-to-go executive presentations, complete with a script, to facilitate group communication.
- The key points of the entire report are summarized in Exhibits II-1 through II-8. On the left-hand page facing each exhibit is a script explaining its contents.

A. I.S. MUST UNDERSTAND STRATEGIC SOFTWARE PERIODS

- Four strategic software periods have been defined for analysis. The first strategic period is the Systems Network Architecture/Distributed Data Processing (SNA/DDP) period, which will extend through this decade and will be characterized by continued centralization of control. The SNA/DDP period will continue to emphasize the strengthening of IBM's SNA/VM/MVS central host systems.

- The second strategic period is the Electronic Office period, which will extend from 1990 through 1995 and will be characterized by integration. The Electronic Office period will emphasize the integration of data processing systems, office automation systems, communication systems, and manual (paper-based) systems into electronic systems.

- The third strategic period is the Electronic Office Expert System period, which will extend to the year 2000 and will be characterized by differentiation into specialized systems. The Expert System period will see emphasis upon common services (Data/Information/Knowledge) to various market segments (industries and professions) and to individuals.

- The fourth strategic period is the Custom Products period, which will extend indefinitely and will be characterized by mechanization. Mechanization is defined as the automation of information services. This period will emphasize automatic attention to the specific requirements (or desires) of the individual user.

B. THE CHANGING SOFTWARE FOCUS

- Last year, IBM had $2.3 billion in software revenue (6% of total revenue), and less than 10% came from Industry Turnkey Systems, Applications Packages, and Data/Information/Knowledge (D/I/K) bases.

- During the SNA/DDP period, IBM's emphasis will remain upon the centralization of control in the top three levels of the pyramid (SNA, Operating Systems, and Data Base Management Systems). Large host processors and large central data bases will continue to dominate the software strategy.

- During the Electronic Office period, the emphasis will be upon integrating the fourth, fifth, and sixth levels (Languages/DSS, Industry Turnkey Systems, and Applications Packages) with electronic office systems.

- During the Expert Systems period, the emphasis will be on differentiation of the integrated electronic systems created in the Electronic Office period. This will be done by specialization of languages/DSSs, industry turnkey systems, and applications packages that will be brought together with level seven (Data/Information/Knowledge) through information networks.

- During the Custom Products period, the strategic trends toward merging of hardware/software/DIK will be mechanized into custom products and service tailored to the individual.

C. IBM OPERATING SYSTEMS: CENTRALIZATION IS KEY

- o IBM has used centralization of systems software at the SNA/Operating Systems level to exercise account control. This strategy has been successful over the past 20 years despite general systems trends toward distributed processing.

- o For purposes of analysis, major operating systems functions have been broken out, and IBM's current emphasis is contrasted with the predominant trend, which can be anticipated based on the current hardware/software environment; this is essentially oriented toward microprocessor-based networks. Being out of step will cause increasing problems for IBM.

  - IBM's current emphasis upon integration in the process function is the only variance from IBM's continuing strategy of centralization of operating system function. This is specifically a result of the need to integrate microprocessors (PCs) under the grand strategy.

  - The only function in which IBM and general systems trends coincide is in storage management, where the need for a "leading part" will be essential if distributed data bases are not to result in chaos.

- o INPUT feels the SNA/DDP strategic period will place substantial strains both on IBM's centralized software systems (SNA/VM/MVS) and on the large host processors to drive them (even considering Sierra, Summit, and MVS/XB).

D. IBM DEVIATES FROM PREDOMINANT SOFTWARE TRENDS

- IBM's current emphasis outside the operating systems area is not quite so oriented toward centralization. However, IBM is still largely out of step with continuing general trends.

- IBM's current emphasis upon integration of DBMSs can best be seen in IBM's DB2 (for mainframes) announcement and in the related extract programs for IMS, VSAM, and sequential files. Micro-mainframe links will facilitate such integration as intelligent workstations become dependent upon mainframe data bases.

- The integration of languages and DSSs can best be demonstrated by IBM's marketing agreement with Artificial Intelligence Inc. for INTELLECT. IBM seems aware that language differentiation is inevitable, and it wants to be sure that these languages become integrated (dependent upon) the higher levels in the software pyramid.

- IBM has had an industry orientation for years, and it is difficult to determine a clear emphasis in Industry Turnkey Systems, since nearly everything is proceeding in parallel. The area will be the focus of shifting emphasis as IBM prepares the Electronic Office period, where such systems are key.

- Applications packages have not been an IBM strength, but the future is clear: the potential revenue (especially in micros) is too big for IBM to ignore. Nevertheless, the current emphasis remains on integration of (dependence on) higher levels in the software pyramid.

- Central control of storage management does not necessarily imply central physical storage of data, but IBM seems intent upon this strategy.

E. MAKE LARGE SYSTEMS MORE PRODUCTIVE

- INPUT believes IBM will become a $100 billion company by 1990. IBM's SNA/DDP strategy of controlling the strategic trend from mainframes to microcomputers to microprocessors has been successful. However, IBM is depending upon highly centralized systems, and there are significant technical challenges to these systems.

- IBM's highly centralized software strategy has been used to fuel demand for large central processors and storage. It is INPUT's conclusion that the demands for the means to manage large data bases may exceed even IBM's hardware/software technology.

- IBM's strategies and challenges during the SNA/DDP period point to the following:

  - Major performance problems on large central hosts will be synergistic with IBM's strategy. These problems will fuel the need for efficient storage management systems, performance monitoring systems, off-loading host applications, efficient protection and security systems, and implementation of host functions in distributed architectures (data base machines, network managers, and performance monitors).

  - DBMSs that have new data/information models for the integration of text/data/image and that incorporate optical disks will begin to appear during the 1980s in anticipation of future requirements.

  - Specialized languages and decision support systems integrated with necessary data/information/knowledge bases will remain a growing need through the turn of the century.

F. PREPARE NOW FOR ELECTRONIC OFFICES

- IBM's revenue goal of becoming a $200 billion company by 1995 depends upon the massive replacement of independently created data processing systems, office automation products, and manual systems with new integrated electronic systems that reduce paper handling. Such systems also imply the replacement of existing computer software and current operating procedures. Optical storage media, turnkey software, and broadband interoffice communications will become essential.

- To the degree that IBM is unable to control the development of integrated electronic offices during the 1980's, the Electronic Office strategy may face substantial challenges from competitive software systems and in-place alternatives that are difficult to replace. At present, IBM does not feel threatened by today's LANs and technology--they can be replaced and IBM can say "we told you so." (The recent announcement that deferred IBM calling systems with LANs for two to three years was not surprising.) A new operating system to replace MVS/XB could be more of a challenge, but the performance problems of the SNA/DDP period will have provided ample warning: Getting rid of paper may meet with sales resistance, but IBM thrives on overcoming sales resistance.

G. EXPERT SYSTEMS ARE COMING

- Will IBM grow tenfold between now and the turn of the century--from $40 billion in 1983 to perhaps $400 billion in the year 2000? If IBM is to approach $400 billion, it must depend upon rapid growth from software and services. (INPUT projects that software and knowledge bases will grow from 7% of revenue in 1984 to 27% of revenue by the year 2000.)

- The challenges to IBM's success are no longer technological during the period but involve difficult questions of network and data standardization, tariffs (how to charge for new services), the specter of regulation, and just plain management problems associated with running the world's largest, most complex private enterprise.

- Implementation of systems that conform to the strategic trends will be limited only by imagination and creativity. Solutions will fall into two general categories:

  - One will be knowledge-based systems to support continuing education from preschool through the retirement years. The rate of change and proliferation of information will make such systems mandatory.

  - The other will be interactive communications that will permit active participation in various activities--from a national BINGO game to electronic voting on pending legislation.

H. PREPARE FOR THE AGE OF INDIVIDUALIZE SYSTEMS

- Just as it became increasingly difficult to acquire hardware without software, so it will become increasingly difficult to acquire hardware/software without Data/Information/Knowledge. For example:

  - Word processing packages are already difficult to sell without dictionaries, and soon parsing and punctuation assistance will be standard.

  - A statistical package will be difficult to sell without including a course in statistics--an electronic textbook at an appropriate level for the user.

  - An integrated system for lawyers will include almost transparent access to the law library. Expert systems will be useless without the knowledge base.

- Users are looking for solutions not systemss. The burgeoning IBM software strategy is predicated on integrated, customized solutions. IS must prepare for IBM's change in emphasis and realize that it is driven by endless needs. IS must satisfy these needs using tools provided by vendors such as IBM or else the vendors will satisfy these needs themselves.

III

III STEPPING OUTSIDE THE IBM SOFTWARE ENIGMA

A. HISTORICAL PERSPECTIVE

- Twenty years ago, in April 1964, IBM announced the System/360. This announcement was the "big bang" that created the IBM universe in which we are all living today.

- At that time, a relatively clear direction was established for both the hardware and software:

  - There would be one compatible line of processors, one operating system, and one language to satisfy both scientific and commercial user requirements.

  - There would be 32-bit architecture from the bottom to the top of the line; the operating system was to be OS/360, and the language was to be PL/1.

  - There was no need for newfangled things such as timesharing, data base systems, or virtual storage--all of which were being offered by competitive vendors (especially GE). It was pointed out that IBM had QTAM for supporting terminals, ISAM to handle files, and OS with 1 M-byte of storage at the top of the line.

- A major survey of all large IBM customers prior to announcement of the System/360 revealed that the most important attribute of systems software was "Ease of Use," and this was established as the primary design point of OS.

o In retrospect, the direction may appear to be quaint, naive, shrewd, or just plain misleading, but the important fact is that the direction was clear--even though there were those in IBM who strenuously dissented at the time.

- Relocated hardware was made available practically overnight when Bell Labs ordered a GE system (after MIT had done the same). This permitted IBM to announce the 360/67 TSS (timesharing system) system, which is a story in itself and will be dealt with when UNIX is discussed.

- TOS and DOS (tape and disk operating systems) were never supposed to have been needed, but when the OS trouble started, they probably saved the whole software effort.

- Then, of course, IBM research discovered "locality of reference" using the experimental M44X virtual system, and this was supposed to assure good performance even in large virtual systems because both program execution and data references tend to concentrate in relatively small segments of storage. Unfortunately, the researchers did not consider sorting to be a very important application, and it was left to the early commercial users to discover "thrashing" in virtual systems.

- Numerous data base systems (or pseudo data base systems) were developed internally by IBM. Some of them were never released, and the old arguments about which were (or are) best continue within IBM to this day.

- o However, despite the deviations, the direction 20 years ago looks like a single laser beam compared to the expanding IBM software universe we are confronted with today. It is necessary to examine the original direction, what motivated the software strategy, what destroyed its coherence, and what has happened since the big bang before we can step outside the IBM software enigma.

- o It is significant that, while terminology has changed substantially, the major issues confronting IBM and the industry have remained substantially the same:

  - How to manage and control costs of large software systems development projects remains a primary challenge to vendors and users alike.

  - The primary design point software systems continues to be at the man-machine interface.

  - The mainstream operating system has grown up from OS/360 to MVS/XA, but it has yet to attract some of those who wandered off to interim solutions like DOS.

  - There are still people who swear by COBOL, FORTRAN, and even assembly language. The Tower of Babel now includes PL/1, BASIC, PASCAL and an assortment of fourth-generation languages.

  - Memory management problems (such as addressability) continue to assail us even as main memory has gone up more than 100-fold to 128 megabytes on the IBM 3084-QX.

  - Data base management systems and their applicability remain controversial in terms of data models and performance.

  - The significance of interactive computing (timesharing or transaction processing) is now clearly understood; how it can best be supported remains a primary issue.

- Problems of "shared files" and security continue as a problem.

o It is safe to say that a lot has been learned over the past 20 years, but much of it becomes lost when one starts confusing terminology and concepts. It is wise to keep this in mind when one briefly traces the tenuous thread of IBM software directions.

B. ORIGINAL MOTIVATIONS AND CHANGING INCENTIVES

o The original software budget for System/360 was estimated at about $30 million: This was deemed to be a lot of money, especially when no one seemed to know exactly what all of those programmers in Poughkeepsie were doing. The motivation for the established direction was quite simple:

- Development, production, and maintenance costs would be minimized by having a single software system (OS/360).

- A single operating system would also facilitate ease of use.

- By having a single language (PL/1), a new de facto standard would be established, and FORTRAN and COBOL could eventually be phased out. (Despite disclaimers to the contrary, this was the original plan.)

- A single effort would focus responsibility and give executive management a better understanding of the software function. Even before the Big Bang, programming systems were referred to as "the mess," and there was great appeal in getting it all together into one organization so that it could receive proper attention.

- The computer architects and engineers could not understand the "long-hairs" in programming. While hardware functional and cost problems were routinely solved by stating that they would be handled in software, the general attitude was (and perhaps continues to be) that programming can be managed and controlled when one brings "engineering discipline" to the software development function.

o The clear direction failed to achieve its objectives. The software plan for System/360 must represent the most serious cost miscalculation of any systems effort that has ever been undertaken.

- To this day, IBM does not know (or does not want to know) how much the cost overruns against the original, rough OS/360 specifications were, but the amount that IBM has "invested" in systems software over the past 20 years would attract attention even in the federal budget. The overruns would have bankrupted any other high-technology company.

- Operating systems and languages proliferated rather than became standardized. Under the great OS/360 umbrella, that system itself evolved into the most complex system ever developed and added a new level of difficulty for both operators and programmers. The primary design point (ease-of-use), even though it was virtually ignored in implementation, was flaunted in order to justify the poor performance inherent in the system.

- PL/I did not become a standard--even within IBM. The resistance was immediate and severe, proving something IBM had already uncovered in research prior to the system/360 announcement: Programmers (or users) do not like to change languages, and it has little to do with functional capabilities. Familiarity is the attraction of languages for most users, and users see no reason to change.

- Responsibility for the software effort was established, and when the development effort went sour, three levels of IBM management (from Corporate Vice President down to Director of Programming Systems) were purged. There was no "penalty box" for the unwitting culprits; none ever returned to the big game. It was a classic case of being in the wrong place at the wrong time. The lesson is still remembered: There won't be many miracles scheduled in IBM's software development effort.

- Software development remains a mystery to IBM management. It is still a "mess" to be tolerated. The concept of bet-hedging is rampant, based on past experience; nothing that is planned ever works very well, but if you spread enough seeds something usable will result.

- It is doubtful that there is much serious talk about software engineering among corporate IBM executives after the OS/360 experience, and it is also doubtful that many engineers would volunteer to try their hand at running the whole show.

- IBM's reorganization in 1981 scattered software responsibility throughout the resulting organization.

- The hardware versus software controversy that started with System/360 development went through one additional iteration with the abortive FS series in the 1970s.

- If doing everything in software was a problem, why not lift software functions and put them in firmware where they could really be "engineered"?

- The "layered" systems approach also proved very expensive, and this approach is not likely to be repeated on a major scale.

- Not many of IBM's original objectives were achieved despite the company's clear direction at the time of the Big Bang, but there is an incredible paradox: Software became the key to IBM's past, present, and future success.

- Software has become IBM's primary revenue generator and account control mechanism. This may not be fully understood by IBM management at all levels, but it is known intuitively.

  - It is probable that in excess of 90% of executed mainframe CPU cycles are running IBM-generated code. The demand for ever-larger processors is created not by customer applications systems, but by new, "improved" versions of IBM's systems software.

  - Demands for both main memory and direct-access storage can be directly related to software. IBM's implementation of virtual storage has increased the need for real storage enormously, and software systems (such as PROFS) encourage using disk storage as a rarely emptied wastebasket.

  - Systems software has become the means of account control. Regardless of technical criticism and grumbling from customers about the IBM mainstream software efforts, IBM sales and support personnel have been remarkably adroit at attracting, leading, selling, threatening, and/or bludgeoning customers into the IBM mainstream and at keeping them floating along with the latest versions. (Consider the resources expended by customers in riding the OS/360 wave through to MVS/XA.)

- Unlike hardware, where software-compatible mainframes have chipped away little pieces of the rock, there have not been serious competitors in the mainframe operating systems area, and IBM would love to lure AT&T into that briar patch. To the degree that IBM tightly integrates software products and services under the operating systems umbrella, it can control direct competition. For example, TSO may not be the world's greatest timesharing system,

but it does have the "advantage" of being unique in that it interfaces with IBM operating systems.

- To the degree that hardware or software vendors depend upon IBM operating systems, they survive due to IBM's mercy, tolerance, and/or indifference; these vendors, therefore, are subject to IBM's control and impact (intentional or unintentional). In other words, they are already in the briar patch.

  . The mere size of IBM's "investment" is enough to scare most competitors and to convince many users that there are no alternatives to IBM's solutions.

  . In addition, users are now charged for functional and performance improvements, and a substantial revenue source has been developed from what was originally "given away" as part of the hardware.

C. IBM'S CHALLENGES, OPPORTUNITIES, AND TRAPS

o The primary challenge IBM faces in the software area is to manage the change associated with the potential shift of power from traditional DP departments toward end users. The essential element of this challenge is to maintain the monolithic operating systems and organizational structure that have been established jointly by IBM and IS management. This will require perpetuation of the belief that there is a direct correlation between the value of software systems and their size, complexity, and expense.

  - One obvious way to do this is to establish high value on such systems. The rather vague concepts of "investment in software" and of "information as a corporate asset" are essential to the strategy.

. The "information as a corporate asset" concept is used to justify new investment.

o IBM has a deserved reputation for being a winner. The major hardware and software competition from 20 years ago has essentially been vanquished (although the GE specter lives on in UNIX). During that period IBM has pulled away from the competition in terms of both market share and reputation.

- Because of maintenance problems over the system's life cycle, stability and reliability of the vendor are more important with complex software systems than with hardware systems.

- The IBM reputation will be worth a lot as software systems become more complex; the inevitable failure of the many small software houses will make this point without undue emphasis from IBM.

- Above all, IBM is, with reason, one of the most trusted institutions (public or private) in the world today. There are tremendous opportunities to exploit this reputation in matters of reliability, dependability, integrity, privacy, and security.

- IBM also has the opportunity to harvest the best and most creative software products from its small competitors, thereby minimizing development risk and substantially lowering costs compared to internal development. There is every indication that IBM recognizes this opportunity, and it does not bode well for the competition, because even if IBM harvests only the second- or third-best products, IBM's overall position will often assure their success.

- Then too, as previously mentioned, even if deficiencies in current software systems are exposed, IBM is most adroit at making the improvements profitable. It all adds up to the rich getting richer and to many of the poor going bankrupt.

- There is one essential trap in all this: IBM has a current vested interest in size and complexity.

D. TERMINOLOGY HAS GROWN FASTER THAN CONCEPTS

- While the complexity of current software systems has been emphasized, it is a complexity of terminology rather than of concepts. As the scientific method of dissection has been applied to computer/communications networks, individual pieces (terms) tend to assume an importance out of all proportion to the whole. This year, for example, micro-mainframe links are all the rage, although they are not a new concept.

- Because of the proliferation of terminology in the industry, and of the necessity (or tendency) for IBM to become involved in everything, IBM's direction may appear to be like the expanding universe or a herd of elephants stampeding in all directions. However, our research for this report indicates that the elephants are only restless in the herd. The old bull (born 20 years ago) is still in charge and moving the herd cautiously through the technological undergrowth. As someone at IBM research stated: "Elephants are relatively hard to stampede, but once they get started they usually get where they are going. The problem is determining the right direction--and patience is a virtue, regardless of how frustrating it gets sometimes."

- INPUT believes that despite the terminology explosion and the resultant alphabet soup, IBM's attention is still focused conceptually on the problems of yesterday (which still exist), and its direction has been established by the "success" of OS/360; in other words, IBM wants one big system for integrating everything. However, now the operating system(s) itself has been subordinated to a new instrument for complexity and control--SNA.

IV

IV RESHAPING THE SOFTWARE PYRAMID

A. A CONCEPTUAL MODEL FOR PURPOSES OF REFERENCE

- SNA (including its human components) is a hierarchial open system of incredible complexity--and one that is unfolding with increasing velocity. Attempts to analyze individual components (announcements) in order to determine the general direction of SNA's evolution are doomed to failure. At most, only a handful of people within IBM comprehend SNA's totality and understand the general direction of its evolution. However, this completely serves an important IBM business need (whether or not originally intended) of controlling the core systems software.

- It is critical, however, for Information Systems (IS) managers and planners conceptually understand SNA/OS and its future directions. INPUT's analysis has shown that general systems theory (GST) is very helpful in classifying and analyzing IBM's software environment, especially where hierarchical, open systems evolve into more complex systems (which is the case for IBM systems software). Four fundamental concepts associated with this kind of systems evolution are:

  - Progressive integration: The parts become more dependent upon the whole.

  - Progressive differentiation: The parts become more specialized.

- Progressive mechanization: Each of the systems becomes limited to a single function.

- Progressive centralization: "Leading parts" dominate the behavior of the system.

o Exhibit IV-1 contains a summary of these fundamental concepts with specific hardware and software examples.

- As terminals (or PCs) are integrated into networks, they obviously become more dependent upon the whole in terms of performance and services required. As big mainframes developed, multiprogramming (and timesharing) was a logical and inevitable direction, leading to interdependence of applications that had previously been viewed as separate. This progressive integration manifests itself today in current micro-mainframe activities, but the concept is basic.

- As integration into large mainframes has progressed, there has also been a tendency to differentiate the host systems by dedicating processors to specific functions (development, production, data base, etc.). Data base management systems are specifically designed to differentiate, for example, between data base maintenance and ad hoc reporting; they encourage specialized groups such as data base administration. Procedural languages tended to become specialized--FORTRAN for engineers, COBOL for commercial programmers, BASIC for the novice, etc.

- General-purpose mainframes--the do-everything boxes--were expected to exhibit a "wide repertoire" of behavior and it soon became necessary to support them with increasingly specialized boxes (minicomputers for process control, peripheral controllers, communications frontends, etc.). This trend continues with the appearance of backend data base

machines. Parallel software mechanization occurs as DBMSs split off into competing systems that "mechanize" specific data models (IMS for hierarchical, DB2 for relational, etc.), and user friendly interfaces make the general-purpose boxes look like an accounting system, an intelligent typewriter, a personnel system, a reservation terminal, etc. Whether through hardware or software, progressive mechanization tends to limit (tailor) the system to a single function.

- As all of the above proceed in parallel, something has to be in charge, and large mainframes (as the designated "leading part" in the IBM system (SNA) must grow rapidly in order to "dominate" intelligent terminals with the power of yesterday's mainframes. At the same time, multiple operating systems have developed, and additional layers of control become inevitable. The design of VM represented necessary progressive centralization and established itself as a "leading part" despite internal IBM political and technical struggles.

o The concepts of GST will be used in establishing IBM software "direction" because they operate regardless of the objectives of the systems architect. In other words, these concepts will define IBM software direction regardless of whether IBM is aware of their operation. At any given point in time, IBM may attempt to establish a direction that is contrary to GST (such as PL/I as a standard language), but if the direction violates the GST concepts it will prove to be self-correcting.

B. THE SOFTWARE PYRAMID DEFINED

o Exhibit IV-2 depicts a software pyramid. The architect is IBM, and the pyramid is arranged in a priority order that is based on IBM's effectiveness in exercising account control. Properly engineered, the pyramid is designed to serve all the needs of any organization.

- SNA and the operating systems are really one and interdependent: OS/360 was the original capstone, but it began to look old and tired at a young age under the onslaught of interactive computing and distributed processing. SNA promises to be much longer lasting.

- Even though the original plans for the operating system's assumed access methods were all that was really needed to construct any system, "data base support" was soon provided by GIS, CICS, and IMS. All of these were supposed to easily work together.

- Once a prototype of the top part of the pyramid had been built (this being a top-down approach), major account expansion programs (MAEP) were initiated in various industries to determine how the system could be used to solve major problems (such as office paper, which seemed to be a primary byproduct of the batch-oriented prototype). Unfortunately, in large part because of the burden of the superstructure, the hardware/software combination for "remote locations" (3790s, 8100s) was not adequate to support much in the way of "office automation," and proposals for advanced concepts such as image (document) processing foundered on the overhead associated with the overall architecture.

- In the meantime, user applications that had been developed on first- and second-generation systems continued to get out paychecks and invoices. Many of these "bread and butter" programs ran for years in emulation mode through several hardware generations. They were not considered too important since they consumed ever-decreasing portions of the CPU cycles. Essentially, these programs were left up to the customer and the local IBM SEs to convert.

- As the base of the pyramid was approached, it was described that data, information, and knowledge had value. Users should have known this

while the top of the pyramid was being "architected and engineered," but they didn't. Now it would be necessary to engineer the corporate data base in order to support the entire structure.

- Unfortunately, it was later discovered that the entire pyramid was being constructed on the shifting sands of user requirements.

o So after designing and engineering the pyramid from the top down, it has now been decided to build it from the bottom up.

o Despite the belated attention to end users and the emphasis on building systems from the bottom up, IBM has no intention of inverting the pyramid. Everything must fit under the architecture that has been established. In fact, in many ways the grand architecture now makes more sense than it ever had in the past.

C. OPERATING SYSTEMS AND NETWORKS

1. MAJOR TRENDS IN OPERATING SYSTEMS

o As previously stated, SNA and Operating Systems are really synonymous and this becomes readily apparent when one considers the fact that operating systems have three broad objectives:

- Maximize ease of use.

- Maximize use of equipment (efficiency and cost reduction).

- Support development, testing, and introduction of new system functions without interfering with service.

- The above objectives were taken directly from the Computer Science and Engineering Research Study (COERS), completed in 1979 and published as What Can Be Automated?

- INPUT accepts the general objectives for operating systems described in the report, the more detailed definitions of the major areas that operating systems address, and the major outstanding problems associated with them. A brief summary is as follows:

  - Process is defined to include provisions for multiprogramming (and multiprocessing), transaction processing, and timesharing.

    - The primary problem identified is interference.

    - Specific work on semantic descriptions of concurrency, process-based language constructs, and data-driven language constructs were mentioned as open questions requiring work (practical implementation).

  - Storage Management as defined in the report is practically synonymous with virtual memory (storage) systems.

  - Protection and Security is defined in the strict sense of "controlling access to computer systems and the information stored in them." However, it was observed that "the growing use of data bases and computer networks has raised new problems that could not be solved by access-control mechanisms alone," and new problems associated with information flow are addressed. In INPUT's opinion, protection and security problems still exist in operating systems, and the associated privacy considerations of data bases are of extreme strategic importance to both IBM and the computer services industry.

- Resource Allocation (and the complex interaction between service and system performance) focuses on the problems associated with achieving "maximum use of equipment" as a general objective of operating systems. In a classic understatement concerning queue and memory management in a multiprogramming environment, the report states: "Determining their combined effect on the behavior of the overall system has proved to be a major challenge of operating systems design." It is INPUT's opinion that there is substantial need for analysis and improvement of resource allocation handling in IBM operating systems, and that predominantly academic research has not solved the performance problems associated with commercial data processing systems.

- System Structure is defined primarily as being supportive of the "effective development, testing, and introduction of new systems functions without at the same time interfering with service," the general objective presented at the beginning of this section. Essentially, system structure addresses the problems associated with the maintenance and extension of large (more than 10,000 lines of code) complex systems. Various programming techniques, concepts, and tools are mentioned; various ordering principles are discussed. Because of the complexity of the subject itself, no general summary will be presented except to state that for the first time an IBM system (VM/370) was given special attention in a subsection on virtual machines. It is INPUT's opinion that virtual machine systems (and VM/370 in particular), being representative of Progressive Centralization, provide the necessary system control to permit restructuring (and reordering) of operating systems functions in extremely imaginative ways. This will be explored later in the report.

- In addition to the operating system areas defined in the COSERS report, INPUT proposes to explore one other area, a layered hardware, firmware, software (HFS) approach that will be analyzed along with the others that were identified above.

o Exhibit IV-3 presents a summary of the operating system areas that have been defined for analysis, and a snapshot of the systems change that will be initiated by today's technological environment. Remember that it is possible for functional areas to exhibit all of the GST progressive concepts, depending upon views taken from particular vantage points within the total system--in this case, a large host(s)-oriented SNA network. The view INPUT has adopted is from the top of the IBM software pyramid. The logic for selecting the predominant GST trends is as follows:

- Connecting intelligent workstations to host mainframes will represent dramatic differentiation of the process function of current operating systems. Batch programs, timesharing computations, transactions against data bases, program development, text editing, etc. all formerly ran on the host and will be distributed to workstations that, at any given point in time, will represent specialized parts of the system. Indeed it is probable that specific workstations will tend to become differentiated in their use, depending upon location and the requirements of the specific user. Two observations concern the progressive differentiation of the process function:

  . The classic problems of coordination and interference are diminished substantially.

  . True concurrency will be obtained with diminished burden on the host.

- Unless chaos is to result when intelligent workstations are permitted to extract data from host systems, storage management must become centralized. There are some very fundamental problems with accomplishing this centralization using classic virtual memory concepts (and implementation). Detailed analysis of these problems is beyond the scope of this study, but the following observations concerning progressive centralization will illustrate the overall problem:

. The necessity for progressive centralization of storage management arises from the need to locate physical storage of data throughout the network and to control its flow.

. While memory management is an avowed objective of virtual memory systems, such systems arose primarily to conserve and manage processor memory at the program (and programmer) level. (At the workstation level, management of processor memory represents progressive mechanization in that individual workstations will perform only one function at any given point in time.)

. The value of current virtual storage or file systems (process isolation, controlled sharing, long-term storage, etc.) becomes amorphous when processing and data are distributed over a network.

. The management of optical storage, which may contain both encoded data and images, adds another dimension to storage management despite the "page" concept of current vertical storage systems.

. It is INPUT's opinion that systems designers will ultimately have to abandon pursuit of the illusion of having one enormous address space. (This will be explored in somewhat more detail as it pertains to IBM implementations of virtual storage systems.)

- Progressive differentiation of the protection and security functions of operating systems will become inevitable in the environment being analyzed. For example:

. Protection and security of intelligent workstations and (associated data) will become more specialized (perhaps built into specific workstations).

. Encryption of data bases and information flow will be differentiated.

. Limits will have to be drawn around certification.

- The crux of micro-mainframe links is integration of network resources. Processing power and data will be integrated and become more dependent upon the whole. For example:

. Offloading of host mainframes effects a shift in available processing resources.

. Data services provided from the host to the micro will cause shifts in storage and access resources.

. At present the impact on resource allocation is unpredictable except to state that this complex problem (which has not been solved to anyone's satisfaction) will become more complex.

- System structure, as pointed out earlier, is an extremely complex characteristic of operating systems. As such, it clearly exhibits all of the trends of GST regardless of the particular environmental change (micro-mainframe links) being analyzed. Consequently the predominant trend will be the Progressive Mechanization of the structure. This conclusion was reached for the following reasons:

. Microprocessors provide cost-effective tools to permit a high degree of specialization of function. For example, a number of years ago, a systems designer in discussing pattern recognition

stated: "Performance won't be a problem; with trends in microprocessor costs, I can allocate a separate processor for each symbol I want to recognize."

. Another obvious example is voice recognition, whereby a particular unit is "conditioned" to understand the specific vocabulary of a specific person.

. The customization (specialization) of intelligent workstations to particular functions, languages, and individuals appears to be inevitable, and it will have the most profound effect upon the systems structure.

- The predominant trend of Progressive Mechanization of operating system structure was the reason for adding hardware/firmware/ software as an additional area for analysis. As specific functions are isolated within the structure, performance considerations will eventually dictate these functions' migration from software to specialized hardware. The functions isolated will span a wide range:

. From custom encryption chips scattered throughout the entire processing and storage hierarchy,

. To set-theoretical data base machines that handle various data models.

o Having established a theoretical base for operating systems trends, it is now possible to compare these trends with currently perceived IBM software directions. To the degree that IBM directions diverge from the GST trends, targets of opportunity will be identified for later analysis.

2. IBM'S GENERAL SYSTEMS DIRECTIONS

- SNA is IBM's gradually evolving plan for distributed processing. SNA has essentially been an exercise in control of network development in order to assure maximum hardware placement. As mentioned previously, SNA has been large host oriented, with monolithic operating systems that have driven the demand for ever-larger mainframes. Despite substantial evidence of more cost-effective solutions, the IBM strategy has been quite successful. A quick review of distributed processing and the IBM strategy for control will provide necessary background information and also a test for the methodology being used for isolation of opportunities.

- For over eight years, INPUT has propounded the geographic and architectural distribution of processing as being inevitable because of cost-effectiveness.

  - The geographic distribution of processing was first presented in the Economics of Computer/Communication Networks and their Future Impact (1976). The schematics of a "proper" hierarchical network have been published in numerous INPUT reports since that time with only minor modifications. The original (1976) revision is depicted in Exhibit IV-4. It made the original points about proper functions at various levels. The points are still valid.

    . Standalone systems between very large mainframes and minicomputers are difficult to cost-justify.

    . Regardless of terminology, the price levels have remained fairly consistent among the various levels and their proper functions.

  - It would not be entirely unfair to say that IBM's past, SNA-oriented hardware/software strategy has been to assure that the proper distribution of functions within this network did not occur. SNA distribution of processing (based on the venerable 3705/3725 and 3790/8100, and their

associated software) has been highly effective seeing that Progressive Integration of hardware and Progressive Centralization of operating systems functions remained paramount in IBM's direction. This choice is at the expense of Progressive Differentiation and Progressive Mechanization of function, which would have been dictated by the proper distribution of function (see Exhibit IV-4).

- The potential for differentiation and mechanization of mainframe processing is considerable. In 1978 INPUT asked users to estimate the percentage of mainframe processing that could be distributed from the host if a backend data base machine was available. The estimates were concentrated in the 70-90% range. Later, the same respondents were asked how much processing could be off-loaded to a frontend communications processor, and the answers concentrated in the 20-30% range, as shown in Exhibit IV-5. This obviously implied that the large mainframe could be totally replaced with a relatively simple distribution of architecture. It is INPUT's opinion that the current trend is toward using a mainframe as an enormous data base machine and that the IBM System/370 hardware/software architecture is not especially well suited for this purpose.

- Even though it is INPUT's opinion that IBM has been very successful in its mainframe-oriented strategy, it is apparent that this has been accomplished in opposition to inevitable trends of GST.

- It is obvious that in the last six years, IBM has been highly successful in preventing any serious erosion of operating systems functions in the SNA environment (although the successful Series/1 has run counter to SNA). The complex monolithic operating systems that are currently represented by MVS/XA slowed some of the natural trends of GST, but they were not to be denied. The installation of standalone personal computers in the corporate environment effectively shattered the highly integrated and centralized systems represented by SNA.

Nothing could have been more dramatic than the reaction to the unnatural restrictions imposed on the normal evolution of computer networks!

- o IBM's current emphasis on intelligent workstations (PC-based) appears to be merely a continuation of the resistance to the proper distribution of processing and data in a hierarchical network. Already, certain "words of wisdom" are beginning to surface among the IBM pundits.

  - "Minicomputers are dead!"

  - "Intelligent workstations will make enormous demands on the host."

  - These statements may be essentially true if IBM's strategy succeeds. Certainly, the 4361, PC-AT and XT/370 represent a direct assault on minicomputer hardware, and the de facto software strategy has obscured the proper distribution of functionality by offering so many alternatives.

  - However, there is no question that the explosion of microprocessor-based workstations and/or systems threatens a dramatic increase in the overall systems entropy and that some central control must be maintained.

- o Before proceeding down the IBM software pyramid, IBM operating system directions will be compared with the predominant GST trends that were described for micro-mainframe links in Exhibit IV-3. The comparison is presented in Exhibit IV-6. The justification for the IBM directions (or resistance to GST trends) is as follows:

  - IBM's response to the proliferation of standalone personal computers in the corporate environment has been based on two perceived threats: (1) true off-loading of processing from mainframes, and (2) the poten-

tial of personal computers to be used as cheap, intelligent terminals. Over a year ago, Don Estridge of IBM stated: "The PC is communications oriented. The day of the standalone is over." The primary impetus for micro-mainframe links from IBM's point of view is integration. Intelligent workstations are going to become more dependent upon other parts of the system--specifically, mainframe hardware, software, and data.

- IBM is cognizant of the necessity for centralized storage management, and this is the only area in which IBM's direction is parallel with that of the predominant GST trend. The preferred manner in which central control will be exercised over distributed storage is an issue of primary concern that will be explored in more detail under data base management systems. However, it can be predicted with some degree of certainty that the primary objective will be the centralization of massive physical storage facilities. (In other words, the strategy will be to increase demands for both main memory and direct-access storage.)

- Because of IBM emphasis upon the centralized corporate data base, the direction in protection and security will also be toward highly centralized control, and this will probably be a major IBM asset in the marketplace. (At this point, it should be noted that the predominant GST trend may not necessarily be "right"--it may signal a potential problem area.) In fact, it is probable that protection and security is extremely important in IBM's overall strategy. Protection and security will be used to:

  . Exercise account control by refusing "certification" for competitive hardware, software, and services.

  . Promote sale of hardware, software, and services through certification of IBM protection and security features and facilities.

. As mentioned previously, the IBM image is going to be hard to beat in this area, but the true cost of an IBM-secured system is going to be high.

- Over a year ago, IBM announced that there were more installed MIPS in PCs than there were in mainframes and this trend has obviously accelerated since that time. IBM's direction in resource allocation will be to assure that those MIPS are not employed to diminish the ever-increasing demand for mainframe MIPS. Since a high percentage of mainframe MIPS are used to execute IBM operating systems software, maintaining central control of resource allocation is not only necessary, but self-fulfilling. This will result in the following:

  . As intelligent workstations are added, requirements for mainframe power will increase sharply.

  . For every dollar spent on workstations, substantially more will be spent (over the life cycle) on host services (processing and storage).

  . Host processing will be extended to the workstation only when it receives its "fair share" of the host operating system burden. (The XT/370 is a good example of how to burn microprocessor MIPS without substantially off-loading mainframes, and this will be explored in more detail later.)

  . The predominant GST trend in system structure would dictate the mechanization of systems functions, but IBM's primary direction is to let individual operating systems proliferate at all levels (host down through PC) and then maintain central software control through VM (or some comparable facility).

. Although selectable modules became a direction at one time, the trend now is toward prepackaged operating systems.

. In INPUT's opinion SNA is in itself a superstructure for exercising "flexible" central control of all network layers, and VM will play a role of great importance in permitting various "minor systems" to orbit around the host.

. Under any circumstances the GST trend toward Progressive Mechanization leads to simplification, and IBM has a vested interest in complexity, which can best be achieved by centralization through continued growth of the leading part (large host operating systems).

- Since the GST trend toward mechanization is what will permit and encourage the isolation of specific operating systems functions, IBM's direction toward growth of the central control function will force the growth of the large central host rather than specialized boxes. This does not preclude the isolation of specific operating system functions and the transfer into firmware and/or hardware--it does mean that these functions and their implementation will be tightly coupled with the host system. However, IBM's hardware/firmware/software strategy will be tempered by a distasteful past experience that was at least as bad as the original OS/360 problems. Specifically:

. IBM's abortive Future System (FS) represented the same type of layered hardware/firmware/software approach that INPUT anticipates will occur in some distributed processing networks. Future System failed. The problem was the scope of the effort and the discovery that maintenance of such grand systems could not be readily "engineered" because of interdependencies at the various levels.

. Only IBM knows how much went down the drain on FS, but one prominant IBM corporate executive is reported to have said: "I can see throwing away $100 million, but a quarter of a billion is enough to make anybody nervous."

. Whether IBM hit a technological brick wall in the FS effort or whether it was merely premature does not make any difference--an aggressive hardware/firmware/software strategy is unlikely (despite the success of the System 38 and customer base).

o IBM's current SNA/operating systems strategy cannot be easily pictured using the software pyramid--it is necessary to turn to the heavens. Indeed, IBM's software directions at all levels can best be pictured by visualizing the attraction of mass, as shown in Exhibit IV-7.

- The mass of the central control function (VM and/or MVS/XA) represents the IBM Progressive Centralization direction that has just been described. It is the primary source of attraction for all of the planned SNA satellites, from intelligent terminals through 8100s to 43XXs. However, there are a number of other aspects of the attraction of mass that are worth noting.

. The total mass of PC-based intelligent workstations is bound to attract a lot of cosmic dust (independent software of all types) into the control of the IBM sun (and it was obviously planned this way).

. Unplanned satellites and operating systems such as the IBM System 36 and System 38 must be accommodated in some manner as the central mass grows.

. Some satellites are planned to grow into suns themselves (43XX, 4381) as they receive a massive transfer of energy from the central source (MVS/XA). The energy causes them to suddenly explode into 308Xs. (This is very much part of the plan; it's as old as the IBM universe.)

. Some minicomputers (especially Series/1) will be loosely accommodated, but they will not be permitted to drain very much energy from the central source. (The orbits will be fixed firmly in process control and other specialized settings.)

- Then, there are spectacular phenomena that have burst upon the scene. They are as follows:

. Flashy little meteorites are expected to fall harmlessly on the major satellites (such things as backend data base systems, full-function communications frontends, etc.).

. At infrequent intervals a comet passes briefly into view, and it is given passing recognition. However, it is hoped that it will just wander off and disappear forever. (UNIX has currently received passsing recognition as the MULTICS comet of the 1960s.)

. Then, of course, there are heavier meteorites that have a rather severe impact on the existing planets; it is hoped that they won't be too frequent and that eventually the craters will disappear and no one will know what caused them. (IBM is hoping that the use of minicomputers for interactive computing will fall into this category.)

- Of course, energy is associated with mass, and a tremendous amount of energy is required to exercise control over all of the satellites in the

IBM SNA solar system. INPUT has become concerned about the expenditure of energy and the inevitable increase in entropy in such complex information systems networks. This concern was explained in some detail in a special combined issue of our Executive Bulletin for End-User/Corporate Systems early in 1984 (Micro-Mainframe Links, the Challenge and Understanding Entropy in Micro-Mainframe Networks. The essential points made can be summarized as follows:

- Shannon established a theoretical link between energy and information through the formula for entropy--"a mathematical expression of the tendency for all things to become less orderly when left to themselves and for energy to undergo certain transformations in the natural course of events, making it more disorganized and not so useful, degrading its quality without diminishing its quantity." Since energy can only be conserved and not created, there is a high potential for chaos developing in inefficent systems.

- At the time it was written, the above analysis was thought to be a unique analysis of potential problems associated with roughly perceived IBM network directions, as signalled by the announcement of the 3270 PC and XT 370. However, during the course of research for this study, it was discovered that at least some scientists at IBM research have become somewhat familiar with the problem. The following unsolicited statement was made: "I don't think many people around here realized the entropy associated with data--it can be measured in the computer room and we can even get it down to the gate level."

- It is doubtful that the awareness exhibited by this observation will have any appreciable effect on IBM software directions in the foreseeable future.

- o IBM's general software directions, as described above, indicate enormous expenditure of energy (human, processing power, and information) in supporting large, centralized hardware/software systems to control the rapidly expanding SNA universe. Unfortunately, these large central systems are not known for their efficient use of energy (processing power).

- o However, it is necessary to come back down to earth and examine some specifics of the IBM software pyramid. (See Exhibit IV-2.)

3. MVS/XA

- o IBM has clearly indicated that MVS/XA is its mainstream operating system and has emphasized that XA is really a new architecture and not just another operating system release. Perhaps so, but it is less innovative in view of the following:

  - Going from 24-bit addressing to 31-bit addressing is nothing new for the IBM users who have been exposed to an FS-spawned System/38 that has 48-bit addressing.

  - While XA will permit a virtual storage of 2 gigabytes and up to 256 channels, even IBM feels it will run out of capacity in the "late 1980s." (This was stated by the IBM Director of Product Strategies, Data System Division at the IBM-conducted Computer Services Conference in 1983.)

  - As someone in IBM stated recently: "XA really stands for extended accommodation." XA's primary purpose is to accommodate the IBM software system, which is growing faster than the hardware to run it. It is paradoxial that IBM now presents "performance ranges" based on the MIPS consumed by IBM's various operating systems without any direct reference to what these systems provide the user in terms of performance. It is even more ominous when the customer accepts such "measures of performance."

- There is no question about which direction IBM wants its customers to migrate--it is to MVS/XA (despite recent enhancements for DOS/VSE). It will become necessary for customers to go to MVS/XA as more and more intelligent workstations (and their controllers and remote processors) start orbiting around the hosts. In fact, it is not going to require very many intelligent workstations to force MVS/XA (or other top-line operating systems) right down into the office environment--all it takes is a start toward electronic filing of paper documents (more on this later).

- Through all of this, major IBM customers may grumble, but eventually they will go.

4. VM/CP

o IBM is currently on record as supporting VM in parallel with MVS/XA, to the extent that the resources being applied to each are equivalent. However, IBM has specifically denounced the implications that MVS/XA has lost favor, stating that both have their place and that there is no plan to provide VM with all of the functionality of MVS. This is probably true. However, it is equally true that VM has become the primary leading part for effecting Progressive Centralization, which is the predominant direction of IBM's operating systems strategy. Consider the following:

- It is a well-publicized fact that VM/CMS will be enhanced (extended addressing) in all its versions, from large hosts down to intelligent workstations. (The XT/370 announcement in itself is significant in its support under VM/CMS.)

- VM/CMS has obviously been selected as the "fighting system" against UNIX.

- o However, more important is the fact that conceptually VM/CP is designed to sit on top of other operating systems--any operating systems--and have users think they are running on their own machines. The obvious potential advantages of this in dealing with both real and virtual machines in the processing hierarchy are apparent.

- o In addition to being the primary vehicle for Progressive Centralization, VM/CP will also permit controlled, Progressive Integration of other operating systems under the VM umbrella; VM/CP will also facilitate Progressive Differentiation as specialized operating systems appear (as they inevitably will--especially for intelligent workstations). It should be noted here that VM also provides "virtual differentiation" for diffident users--"Oh, the XYZ operating systems is okay if that's all you want to do--it will run under VM." Thus, the XYZ operating system, which may be precisely what the user needs, is automatically subordinated to VM and classified as a special situation--to be corrected later.

- o The center of the IBM software universe has two hemispheres and both are of equal importance: MVS/XA (and all its inevitable releases, extensions, etc.) is for the direct control of the SNA-prescribed satellites, and VM is for the control of the wondering comets and phenomena that haven't quite settled into firm orbit yet.

- o VM/CP is a natural. Over the years it has remained out of the mainstream and relatively clean, but there is one negative aspect--it does add a burden to the already-laboring control engines. While discussing this VM scenario with an ex-IBM employee, it was agreed that VM was a logical vehicle in the environment that has been described--"But," the employee said, "they will probably find some way to screw it up."

5. UNIX ANYONE?

o At IBM Research in Yorktown Heights an academic environment prevails, and where an academic environment prevails there are those who are familiar with UNIX. The most succinct advantage put forth for UNIX by these IBM employees is: "It is containable in the human brain." This is a nontrivial advantage.

- It means that UNIX is understandable and its functions can all be comprehended--it is easy to use. Thus it satisfies one of the broad operating systems objectives presented earlier.

- In addition, UNIX is generally a clean system, and certainly makes more efficient use of hardware than does VM/MVS. Therefore, the second objective is met.

- The lack of complexity (and function) that leads to both of the above should also permit more "effective development, testing, and introduction of new systems functions" and satisfy the third general objective.

- It seems apparent that, at least by the standards of the COSERS committee, UNIX is a pretty hot item. However, the academic orientation of the committee should be remembered, and there is no question that UNIX was born and bred in an academic environment.

o Observers have raised the question of whether or not UNIX can be ported to large mainframes with sufficient function to satisfy complex commercial environments without losing UNIX's current advantages. While it is no trick to improve on the performance of IBM systems (from the perspective of both hardware and ease of use), it is probable that there will be some rude shocks awaiting UNIX when and if it is extended beyond minicomputers (and even down to microprocessors).

- o Regardless of how well the transition is accomplished, IBM's probable tactics are clear.

  - UNIX will be labeled an academic, minicomputer-based operating system modeled on a system (MULTICS) that goes back in history farther than MVS.

  - Functional comparisons will be made against all available IBM systems, regardless of significance in the particular situation, and UNIX will always be found wanting.

  - VM/CMS will be enhanced as a specific competitior in particular market segments.

  - Failing all else, UNIX will be provided by IBM--"if that's what you really want." The question of whether or not IBM's particular version of UNIX is the best is moot, but as far as IBM is concerned, its version will be UNIX.

- o VM/MVS (and the rest of the IBM software universe) exceeds the human brain mass of even the most seasoned systems programmer. Pity the poor UNIX marketing representative who gets engaged in a technical discussion of the relative merits of his product with an IBM-indoctrinated IS department--just the terminology will be an enormous barrier. It is probable that the comet will pass from view without serious disruption to the IBM solar system.

6. MICRO-MAINFRAME CONNECTIONS

- o IBM is prepared to support multiple-PC operating systems and an infinite variety of connections to the mainframe--through controllers, small business systems, mid-range mainframes--practically anything except minicomputers, which have a bad connotation for IBM.

- The announcements of the 3270 PC and XT/370 were precursors of IBM's distributed processing strategy.

  - Intelligent workstations are made to look like 3270s, and they are permitted to tap into multiple data sources at various levels within the processing hierarchy (remote mainframe, local controller or processor, and/or personal data bases).

  - The XT/370 announces to the world that, if you are going to have the processing power of an IBM mainframe (of recent vintage) on your desk, it should look like an IBM mainframe, and be supported by real software--like CMS.

  - Both the 3270 PC and XT/370 have two other significant ramifications.

    . They can be used on a standalone basis, but their real justification and "proper use" must be under the great SNA umbrella. (Progressive Integration)

    . Both are designed to put enormous pressure on minicomputers and their functions (see Exhibit IV-4).

- The strategic importance of IBM's signaled direction in micro-mainframe links is to redefine the distributed processing hierarchy and eliminate high-performance minicomputer systems operating under reasonably efficient operating systems such as UNIX.

  - Large mainframes will provide centralized control of the network and distributed data bases.

  - Intelligent workstations can be used for program development and maintenance (forget the current XT/370 and VM/CMS limitations--IBM always proceeds carefully in these matters). Intelligent workstations

can also be used for simple transaction processing against personal data bases.

- Scientific timesharing can be split between the workstation and the host.

- Thus, we have the VM/CP and MVS/XA threads running from the large host mainframe through remote processors (including controllers) to intelligent workstations without benefit of significant distribution of processing power (or centralized control) from the host system.

o Early experience with XT/370s has led to some important conclusions:

- The 12-bit addressing limit and 20 M-bytes of disk storage place a severe limit on the use of the XT/370 for program development and maintenance.

- Even compilers tax the storage limit (which is also indicative of how the host software has grown; perhaps some attention should be given to compiler writing again).

- While the XT/370 may be slow for most things, it does provide "more-or-less instantaneous response for editing on the screen." These goes back to the proper functions of an intelligent terminal, as defined by INPUT over eight years ago.

o Nothing could be more indicative of IBM's emphasis upon maintaining centralized control (and its resistance to Progressive Differentiation and Mechanization) than its continued reluctance to distribute processing and functions from the mainframe (see Exhibit IV-6).

7. LOCAL AREA NETWORKS (LANS) AND SNA

- IBM personnel have adopted a rather quixotic and yet pragmatic view of LANs:

  - They give credit to the ETHERNET advertisements for the acceptance of LANs. They then emphasize that LANs address the cabling problem and not the problem of connecting terminals.

  - Years ago IBM personnel pointed out that terminals hanging off 3790s and other cluster controllers were really local area networks. In other words, "What's new?"

  - There is a general undercurrent of condescension on IBM's part concerning LANs. IBM implies that competitive vendors have created much ado about a subject that is not very well understood--and, indeed, there is a great deal of truth in this assessment. However, it is rather amusing to see IBM placed in the position of tilting at windmills for a change.

- Having been placed in the unusual position of being victimized by a vague conceptual solution to a complicated problem, IBM has been reasonably straightforward in defining the problem (if not the solution). This response has provided a valuable insight into IBM's thinking and general direction on LANs. Public statements from IBM are revealing.

  - It has been pointed out that the primary goal of LANs is to wire once and have independence in terms of terminal attachment. It is then pointed out that this is complicated by the various types of information that must be handled.

    . Noncoded information such as voice and full-motion color images can require from 64 K-bits/sec up to 2 M-bits/sec.

    . Coded data requires only hundreds of characters (thousands of

bits) per screen, but coded information (images) requires hundreds of thousands of bits per screen.

. The implication is that, if you only want to cable once, you had better be careful what you cable for and with.

- Concerning media, IBM points out the inflexibility of CATV cabling, the current availability of shielded multiple twisted-pair wires (for up to 64 K-bits/sec), and hearty endorsement of fiber optics for the future. Properly, IBM considers broadband as ideal for video and TV, and baseband as being "very good" for digital office communication. In other words, arguments about broadband versus baseband are meaningless--both will be required depending upon requirements and available technology. The message becomes one of "go slow," and it isn't a bad message for most IBM customers.

- Regarding topology, IBM is quite clear in terms of preference.

  . Mesh networks, in which all systems are connected to all others, are only practical when there are only a few systems to be connected.

  . Star networks are only practical at up to 64 K-bits/sec because of switching limits.

  . Bus approaches (such as Ethernet) present problems when something goes wrong--it is difficult to detect where the problem is, and there are physical limitations when the medium breaks.

  . Tree approaches (such as Wangnet) are easy for cabling buildings but they suffer from the same problem as the Bus approach in that a break in one system can interfere with other systems.

- . With everything else practically eliminated, IBM points out that Ring approaches are preferable because backward transmissions are possible in the event of a break.

- . The message here is simply that IBM has carefully considered alternatives and has selected the most reliable and versatile topology.

- . With its Ring topology, IBM emphasizes token protocols.

- With redundancy necessary to clear the noise from the network, the message is repeated: (1) LANs are a complex subject, (2) there is not a single solution, (3) be careful if you are a user, and (4) IBM has your best interests at heart.

o Having described most of the current LAN controversy as a "tempest in a teapot," IBM has also described a broader communications perspective based on SNA and the requirements for networked office systems. This environment will be supported by new telecommunication services.

- SNA's objective for the 1980s has been stated as:

  - . Very large network support with expanded addressing capability will permit connection (or interconnections) of networks. (Remember that MVS/XA addressing capabilities are being exceeded in the late 1980s.)

  - . Non-SNA device attachment is anticipated (and presumably will be facilitated).

  - . There will be new data network attachments and enhanced network management capabilities (hopefully).

- New communication products from IBM will emphasize new functions, ease of use, and interconnection.

- Software distribution will be incorporated under SNA.

- The networking of office systems has been described as involving three key IBM software architecture considerations:

  - Document Content Architecture (DCA), which will permit content definition (including voice notation) and will cover creating, editing, formatting, and presentation.

  - Document Interchange Architecture (DIA), which permits information to be stored in documents and in appropriate document library services; it covers distribution, filing, retrieving, searching, information description, and application control.

  - Connectivity through SNA, which will provide the communications interface between various products through a variety of architectural approaches (from simple PBX approaches to global systems).

- Thus, office systems (LANs) will become progressively integrated under the great SNA "leading part," which will provide the necessary centralized control. IBM considers the layering of the SNA architecture to be extremely important, and this has been defined as follows:

  - The first layer is application presentation, which can be divided roughly into data and text.

  - The next layers are session, then transport, then network, then data link control, and finally physical control.

. Then, of course, there are the interfaces with communications buses through various standard protocols.

. The really important thing, from IBM's point of view, is that the user interface, from applications presentations to physical activity, is really SNA code embedded in individual products.

- LANs are then considered a subset of networked office systems under SNA. As such, IBM sees extensive chip development to permit token-based local area network configurations. The design considerations that have been listed are:

  . LANs should be high speed--ultimately in the 10-1,000 M-bytes/sec range.

  . LANs should use existing wiring, conform to international standards, present a single solution, and have long life (defined as 15-30 years).

  . The cheap attachment of low-cost workstations is essential.

  . Thus, LANs are put into their proper perspective (from IBM's point of view) regardless of whether you start from the bottom or the top of the software pyramid.

- IBM sees SNA "maturing" in the 1980s and anticipates that the telecommunications industry does have a role to play in all of this. IBM anticipates that:

  . Voice and data will become integrated and standards will emerge.

  . Common carriers will provide integrated voice-data services,

including voice annotation documents.

- Document distribution networks will emerge.

- The Bell System and other common carriers will be very active in supporting many of the requirements as envisioned by IBM. (And presumably proscribed by SNA and networked office systems.)

- Information services networks will proliferate, with implant telecommunication services based on PBXs and LANs.

o Essentially, IBM sees its customers' requirements (as defined by IBM) driving the communications revolution, which is coming to the office (and eventually the home). At the time IBM invested in Satellite Business Services many years ago, the statement was made that this was being done because the primary common carrier (the Bell System) was not being responsible to the data communication needs of IBM's customers. IBM has now extended the requirements of its customers to networked office systems, and it is encouraging competition in the provision of backbone services. All IBM wants is its fair share of terminals and software as defined by SNA; IBM is willing to leave basic transmission services to others. The only qualifiers are as follows:

  - IBM's fair share is not going to be small.

  - SNA is still in the process of maturing (it will continue to grow).

  - Just in case the common carriers don't come through, there is always IBM Information Network Services and joint ventures for the delivery of value-added services such as video text.

o Describing the top of the IBM software pyramid (SNA and Operating Systems) was quite complicated, but once that direction is established, the impact on

subsystems, languages, applications, information, and even end users can be readily depicted and described with rather simple examples. Whereas IBM systems software directions were depicted as a solar system (Exhibit IV-7), the ultimate attraction of that system may mean that it collapses into a great "blue hole" that gobbles up everything (including MIPS), as shown in Exhibit IV-8.

D. DATA BASE SYSTEMS

- One year ago, INPUT prepared an Information Systems Issue Report titled Relational Data Base Developments," (August 1983). IBM's data base directives were projected in that report, and they will be summarized here. (For more detailed analysis and background, that report is recommended.)

- The DB2 general architecture is depicted in Exhibit IV-9. The fundamental facilities are as follows:

  - MVS users may access DB2 through the IMS/VS data communications feature, CICs/OS/VS, and TSO. Users can also access DB2 in batch mode.

  - The Query Management Facility (QMF) allows users to extract, manipulate, and interactively generate reports using IBM's Structural Query Language (SQL) and Query-by-Example (QBE). Data definition functions are performed using SQL.

  - Data Extract (DXT) "extracts selected operational data" from IMS/VS or DL/I data bases, VSAM data sets, and sequential (SAM) files. Then DXT prepares them for loading into DB2. DXT is "designed for programmers or users" to facilitate extract requests that are supported as follows:

. One or two views of the data when it is extracted.

. An OS/VS DB/DC data dictionary can be used for stored data.

. Dialogs under QMF allow interaction request construction and submission, and consist of Interactive System Productivity Facility panels that guide the process of creating an extract request.

. JCL prompts, user-configurable model extract statements, and request submission capabilities are also included.

o This rather detailed description of DB2's general architecture is included in this report primarily because it demonstrates the Progressive Integration of data base subsystems and other parts of the IBM software pyramid.

- At present, the extract programs facilitate the creation of relational data bases from existing files and data bases, and are the primary means of creating the relational tables that form the data base. It is important, in this particular case, to distinguish between the various systems components that are being integrated and the manner in which they are being integrated.

. The obvious dependence of DB2 upon other parts of the system for data is important primarily because it, in turn, facilitates the integration of intelligent workstations serving as decision support systems for users.

. IMS, which has stood as a monolithic system in its own right, now becomes a functional part of something bigger, and it is only a question of time before data flows back into IMS from DB2. (This will, in fact, happen almost immediately--it is just a

question of how easy the process will be made.)

. The more subtle integration of sequential files with relational data bases in many cases will actually serve as a mechanism for reactivating functionally dead archival files by making them easily available to end users.

- It is also important to recognize that the extract programs themselves are batch oriented (especially against sequential files) and that the general architecture for DB2 represents a major step toward batch and interactive process integration. The interactive user sitting at the intelligent workstation becomes dependent upon both batch turnaround and terminal response time.

- The Query Management Facility integrates two query facilities (SQL and QBE), which were developed independently (and even in competition with each other) within IBM.

- Operational (production) and planning data bases become more integrated and dependent upon each other.

- While the announcement of DB2 by IBM was greeted as an endorsement of relational data base systems in general, its integration within the IBM software pyramid (at many levels) clearly demonstrates that, from IBM's point of view, it is not the answer to all the world's problems. For IBM, the total system is the solution.

o The previously cited INPUT report, Relational Data Base Developments, contained an analysis of performance considerations of DB2 based on IBM's documented experience with System R (an IBM research prototype). Simply stated, INPUT's conclusion was that there were performance effects associated with the relational model. INPUT concluded that these effects were intrinsic. In addition, it was concluded that the architecture of IBM hardware

leaves a lot to be desired in implementing any data base system.

- Regardless of the reason(s), it is INPUT's opinion that IBM's primary data base direction is toward total integration, and that this direction will impose (and expose) intolerable performance problems. Consider the following scenario:

  - A user that has been using a personal computer with a "relational-like" data base system has now cost-justified an IBM intelligent workstation based on reduced use of the central data processing facility.

  - The data needed from the corporate data base is contained in archival, sequential tape files. The user initiates an extract on the sequential files, builds relational tables, executes a JOIN and SELECT against the relational tables, and creates his personal data base, which is transmitted over the micro-mainframe link.

  - Assuming that the associated files and tables are large, the impact on both the performance of the 30XX host system and on the user's bill from the central facility will be apparent. In addition, the impact on other users of the system (in terms of responsiveness) will be a clear indication of the interdependence of integration.

- While the scenario may appear somewhat exaggerated, it is realistic. The fact that the system was "not designed" to be used (or misused) as the scenario describes is immaterial--the system will be used against large files and tables to extract small personal data bases. Providing easy access to data bases practically assures less-than-intelligent use, and deep integration compounds the already serious performance problems associated with IBM data base systems.

- It does not appear to INPUT that IBM is rushing toward hardware or software solutions to either the intelligent use or performance problems that INPUT feels are inherent in IBM's current data base direction. If host computers are

literally going to be turned into big data base machines to support intelligent workstations, as shown in Exhibit IV-10, it is doubtful that a 308X operating under MVS/XA/IMS/DB2 is going to be very competitive with more specialized data base machines and/or systems.

E. LANGUAGES AND DECISION SUPPORT SYSTEMS

- The subject of computer languages covers an exceptionally wide range, from a machine language to personalized systems that translate a particular person's audio instructions into computer programs (e.g., response or activity). A comprehensive discussion of languages is well beyond the scope of this study, and even seems to defy the computer industry's current terminology and classification systems (language "generations" are becoming fuzzy and never adequately addressed the problem anyhow). Languages have been combined with decision support systems in order to narrow the range of languages that are addressed--essentially languages will be those that facilitate computer use by nonprogrammers.

- All algebraic languages fall into this category since scientific notation is known to engineers and scientists that must use computers in their work. The relative merits of FORTRAN vs. ALGOL et al. will not be discussed. However, for those who do not recall (or do not care to recall), it should be pointed out that COBOL was supposed to be usable by nonprogrammers also.

- Neither COBOL nor PL/I achieved their objectives because Progressive Differentiation was, and continues to be, the predominant GST trend in language development. While IBM seems to recognize the inevitability of specialized languages (as demonstrated by its endorsement of INTELLECT by arranging a marketing agreement with Artificial Intelligence, Inc.), there is also equal emphasis on the integration of languages into more complex systems. (This is pointed out in the DBMS discussion above, where QMF

incorporates both SQL & QBE.)

o Decision Support Systems (DSS) rest squarely in the middle of a terminological tangle that includes Management Information Systems, Information Engineering, Expert Systems, Knowledge-Based Systems, etc. IBM has had a lot of help in creating the buzz words by which users have been kept confused and at bay, but complex terminology only conceals flawed concepts and lack of progress for a limited time. It is important to take a look at what, hopefully, has been learned about DSS (by any name):

- Elaborate software systems (including easy-to-use languages) without high-quality data are worthless. In fact, they can facilitate bad decisions if the quality of data is poor.

- Building high-quality, complete (corporate) data bases is an enormous amount of work, and thus data bases are always out of date before they can be developed. This has traditionally been attributed to users not knowing what they want, but can more properly be ascribed to the fact that business requirements change. In fact, it is probable that the mere availability of DSSs (and appropriate data) generates new and different demands for data.

- Data are not information, and the availability of vast amounts of data (even if of good quality) can obscure the "message" (information) and literally overwhelm the decision maker. Similarly, vast amounts of readily available information can result in information overload.

- The decision makers do not understand how they make decisions in specific areas. Work in expert systems reveals this quite clearly--the doctor reaches a certain point where the decision (diagnosis) becomes intuitive. Substantial analysis by a "knowledge engineer" (another horrible term) is required before the doctor can accurately describe even a relatively simple decision process (diagnosis).

- It is INPUT's opinion that specific "expert" areas such as medical diagnoses, despite their complexity, actually lend themselves to DSS more readily than do the more amorphous areas surrounding business planning and decision making. (INPUT explored this area in some detail in Impact of Office Systems on Productivity, November 1983.)

o One thing seems clear in all this: data, information, and knowledge must become tightly integrated with programs (decision or inference structures) and user interfaces (languages and/or command structure)

All three must be present if the DSS or Expert System is to be of value, and if the entire system will be dynamic and interactive among its parts--knowledge, decision structures, and interfaces will be constantly changing as they interact. Accompanying the Progressive Integration of the structure of such systems will be the Progressive Differentiation (and even Progressive Mechanization) of the systems by occupational area, profession, and specialty.

o It appears that IBM is moving slowly in language differentiation, and is attempting to integrate DSS with higher level systems (DBMS and operating systems) rather than with the lower level of data, information, and knowledge. In addition, the higher level integration tends to offer general-purpose business DSSs in opposition to the inevitable GST trends of Progressive Differentiation and Mechanization mentioned above.

F. INDUSTRY TURNKEY SYSTEMS

o IBM has had an industry orientation for many years, regardless of fluctuations in organizational structure designed to either emphasize or de-emphasize this orientation. This represents a high-level systems differentiation of IBM's customer base. The strategy is both simple and effective:

- A selected client (or clients) within an industry works with IBM in developing systems that apply IBM's latest hardware/software systems.

- IBM systems engineers assigned to the joint development effort become familiar with the underlying systems and procedures associated with the company (and industry) and can subsequently be used for sales support and/or joint implementation efforts in other companies.

- The benefits to IBM of such a strategy are readily apparent: the specific applications knowledge is of great value, actual software appropriate for other companies may result, and the partner may be used as a reference within an industry (assuming the joint effort is successful). In addition, IBM establishes firm account control.

- There are obviously varying degrees of relative effort on the part of the partners, but usually the customer contributes substantial free development effort to systems that IBM can then install relatively cheaply with other customers. In some cases, IBM might even charge the joint partner for its contribution to the effort, and still reap the benefits.

- While the value of software (including information and knowledge) is becoming more readily apparent to everyone, IBM continues to have tremendous advantages in joint development (and debugging) efforts with its loyal customer base.

o IBM must cover all industries and the degree of success in penetration varies over time. Competitors frequently open up major new areas, such as retail point-of-sale systems, with virtually no competition from IBM. However, after a few years, IBM will have major joint efforts underway with industry leaders. (Cooperative ventures between IBM and Sears may not replace all Sears point-of-sale terminals overnight, but you can be sure there will be an

increased IBM orientation in major Sears systems.)

- o A case study of IBM's industry efforts will serve to demonstrate both specific results and future directions in industry software systems. In the early 1970s, IBM had parallel efforts proceeding in the insurance industry under its Major Account Expansion Program (an appropriate title).

  - At Royal Globe Insurance, a conventional systems approach under IBM's newly announced SNA was undertaken. The purpose was to automate branch office operations, and the results were as follows:

    . The limitations of the 3790 were clearly exposed, but software in the form of the Display Management System (DMS) was developed and became an IBM product.

    . The jointly developed systems provided IBM with not only detailed knowledge of the requirements of property and liability insurance company office automation, but also specific information concerning the market potential for distributed processing systems (SNA products) in that industry.

    . The IBM project leader of the joint effort became sufficiently knowledgeable about insurance systems to become the first president of the Insurance Institute for Research--IIR (more on IIR later).

  - At State Farm Insurance, extensive work was done exploring image processing systems to substantially reduce paper handling (processing) in office operations.

    . It was concluded that, while the system could be cost-justified, it would not be installed at that time. Detailed reasons for that decision were documented and presented within the industry.

- From this effort, IBM obtained information concerning the limitations of current technology's (especially its own) ability to implement such systems, and the requirements for new hardware/software technology in terms of both function and cost.

- IBM also became knowledgeable about other factors (drastic reorganization and changes in specific job content) that contributed to customer resistance to such systems. These factors applied across industry lines.

- Valuable long-range planning information on the processing and handling of documents on local area networks (a term not then coined) was obtained, and this probably influenced IBM's sense of timing on image processing technology and its applications.

- Following the thread from Royal Globe to IIR and beyond will give some indication of IBM's directions in industry systems.

  - IIR was established to develop a shared network connecting a sponsoring group of property and liability insurance companies with their various branch offices (agencies) and with independent insurance agents (the organization of independent insurance agents is also a sponsoring organization).

  - A prototype network was developed and demonstrated to its sponsors by IIR.

  - When it became time to implement the operational network, IBM's Information Network Service (INS) was selected in competition against the Bell System.

  - The IIR contract (IVANS) became the first major INS victory.

- Forty software companies are providing agency systems for both IBM and non-IBM computers that will be connected to the network.

- The major IIR systems effort at present involves standardization of network software (including data elements).

- IBM's INS has provided "millions of dollars worth of systems effort at low cost" to IIR in this effort. The expectation is that the investment will be recovered when the transaction volumes under IVANS start to "mushroom."

o The value to IBM in facilitating interorganizational connection within industries is obvious, and IBM has a stated strategy of pursuing network interconnection (both public and private) and the connection of "non-SNA" products and systems under SNA. The IBM direction is clearly one that encourages Progressive Integration within industries.

  - As the hardware/software parts of the system become more dependent upon each other under this strategy, it is predictable what will happen to the "non-SNA" parts.

  - In addition, the central role assumed by IBM in standardization to facilitate interconnection will inevitably expose IBM's primary emphasis on Progressive Centralization (control by a leading part) of network/operating systems software. This integration and control through standardization will affect not only "non-SNA" parts of the system but vertical applications at all levels within the network hierarchy.

o The level of differentiation represented by IBM's industry approach to software systems development and marketing reveals a level of future systems

commonality that INPUT believes will establish IBM's direction for office automation in the late 1980s. Specifically, INPUT believes that IBM's emphasis upon document processing will lead logically to industry turnkey systems that will substantially reduce office paper processing. Such systems will integrate conventional data processing applications (encoded data) with office systems (documents, images, voice) so tightly that there will be little room for mixed systems.

o This general strategy will be based on the things IBM knows from its own internal experience and what it has been able to deduce from work with its customer base.

- IBM has certainly become aware that SNA-based distributed data processing and ever-expanding office systems are really addressing the same problem set from opposite points of view. IBM was reorganized in 1981 to eliminate the cutthroat competition (between the Data Processing Group and the General Business Group) that was beginning to surface in its customers' offices.

  . These conflicting product solutions for the office still exist and have been compounded since then by PC-based workstations.

  . The loose integration of these diverse products may seem excruciatingly slow to customers, but IBM's 1983 financial results can buy a lot of patience in Armonk.

- In addition, IBM knows certain things from the State Farm experience (which are supported by comparable work in other companies and industries). The reasons State Farm gave for rejecting an essentially paperless office environment that would have provided cumulative cost savings of 10% during the decade of the 1980s were as follows:

  . New hardware would be required (scanners, image display

stations, and storage systems), and it would have to be introduced in the work environment.

- New and more complex software would be necessary in order to handle both interactive and image display stations.

- New applications software would be necessary.

- Since savings would be achieved by reducing the number of clerical workstations, significantly new work flows would be required.

- New jobs and job descriptions would be necessary and an entirely new organizational structure would be required.

- In other words, a one-time massive change would be required and the company (probably wisely) was not prepared to take the risk. IBM was probably just as happy about the whole thing because of the new hardware/software requirements. However, when the time is ripe, this is precisely the type of opportunity IBM loves to exploit--massive replacement of obsolete hardware and an opportunity to bundle software back in. Plus, a perceived high risk from the customer's point of view will practically push the customer to IBM.

- When will the time be ripe? When IBM has all the necessary pieces in place and needs the increased revenue. (INPUT's best estimate of timing will be contained in the next chapter.)

- Will customers be prepared to take the risk? Yes, even with today's technology, savings substantially in excess of State Farm's 10% can be projected.

G. APPLICATIONS PACKAGES

- Applications packages are a sore subject with IBM. Everybody from corporate executives to salespeople are unhappy with IBM applications program products. It is a long, sad history and IBM 's reputation has really suffered for an extended period. Comments received illustrate the IBM attitude:

  - "We still hand tool applications--development is labor intensive and our labor is expensive."

  - "They are designed to solve everybody's problems and they don't solve anybody's."

  - "Those guys (the developers) don't have any imagination and I don't see it changing."

- Specific applications programs don't account for much IBM revenue and there generally seems to be an attitude that the sooner that current applications programs get swallowed by the "Big Blue Hole" of IBM systems (and custom) software, the better.

- However, there is one area that cannot be ignored, and that is the PC, where applications packages are projected to be significant revenue producers as a percent of hardware revenues. It is also in the PC area that IBM feels it has the solutions. Since successful software products in the PC market are like best sellers in the publishing industry, treat them that way. Pick the winners (or near winners) and sign them up with a publishing agreement. The writers (package developers) will make more money and so will IBM.

- This is what IBM has learned from its Series I and PC experience--let others develop applications (IBM isn't very good at it). IBM can always attract the winners (or make winners out of also-rans). In fact, IBM has adopted a confi-

dent (not to say arrogant) attitude along with its new-found flexibility in the marketplace. The following case concerns hardware, but will serve to illustrate the point:

- The potential for optical disks to affect magnetic disk sales within two to three years was raised as a problem with an IBM corporate vice president.

- The reaction was, "I will believe it when I see it, and when I see it, we will take it (the market) away from them."

o Nevertheless, IBM's primary strategy is the Progressive Integration of applications software with the more complex systems resting above it in the software pyramid, and below it in the form of necessary data, information, and knowledge.

H. DATA/INFORMATION/KNOWLEDGE

o The advance of computer/communications technology has proceeded rapidly--from data processing systems to information systems to knowledge-based systems with very little regard for some fundamental problems associated with the underlying data/information/knowledge. The promotion associated with the "information age" has failed to recognize or acknowledge these problems, and it is doubtful that they are generally understood. However, as the frequent references to this level from higher levels in the pyramid indicate, IBM software directions (and General Systems Theory) will soon lead to complex systems where these problems can no longer be ignored. Briefly described, these problems are as follows:

- There is entropy associated with data.

- To the degree that knowledge is based upon information, it is obviously subject to entropy, but the problems with knowledge-based (and decision support) systems are compounded by other problems. Since decision support systems by definition include the "human element," the mathematical foundation (as well as the data/information knowledge base) of such systems is currently open to question.

- As if all this were not enough, many problems in both operations research and artificial intelligence currently have "solutions" that require comparisons or searches that increase exponentially. These researches can quite rapidly exceed the capacity of any computing resource that currently exists or can ever be created. (See "Complexity and Transcomputability" by Hans J. Bremerman in The Encyclopedia of Ignorance.) In other words, the physical limits of computer technology become a very real barrier on relatively "simple" problems. For example, operations research techniques can provide solutions for the "traveling salesman problem" for 10 cities on a personal computer, but 100 cities would exceed the power of any computer system.

o These problems are presented because computer software directions can no longer be dictated by systems designers (or even IBM) without regard for the physical attributes of data/information/knowledge, communications networks, and the limitations of both current theoretical solutions and computer technology.

o IBM's projected structure for distributed data/information bases is presented in Exhibit IV-11. The predominant IBM directions that give emphasis to Progressive Integration of processing and Progressive Centralization of data/information/knowledge will inevitably encounter the problems described above--and very soon. This is true despite the fact that conceptually integration and centralization are precisely what is required if chaos is not to develop from the current rush to distribute processing, data, and systems development responsibility to end users.

I. SUMMARY OF IBM SOFTWARE DIRECTIONS

- Exhibit IV-6 plotted IBM's primary operating systems software directions against the current predominant GST trends. At this point, it must be re-emphasized that as systems become more complex, all of the GST progressive trends of integration, differentiation, mechanization, and centralization occur simultaneously. What the matrix depicts is our best judgment as to the primary current emphasis of IBM software directions compared to current predominant GST trends.

  - In operating systems areas, IBM exhibits continuing emphasis upon centralized control in all areas except process. (In process, integration specifically of personal computers is the direction being emphasized.)

  - In only one area (storage management) did IBM directions and the observed, predominent GST trends coincide.

  - Because of IBM's unique position of effectively dominating the large-scale operating systems environment, these deviations of emphasis may be viewed as either conscious or unconscious efforts to control the GST trends in terms of timing.

- The IBM directions and predominant GST trends for other levels of the IBM software pyramid are depicted in Exhibit IV-12. Languages and DSSs have been split out for separate analysis because directions and trends for the two were not deemed to coincide. The following observations concerning the designated directions and trends will help in understanding them (these are in addition to the comments already made concerning operating systems):

  - The IBM directions should not be confused with specific IBM announcements or statements of direction. For example, the announce-

ment of the 8100 was heralded as IBM's plunge into distributed data processing (with a separate operating system--DPPX--for support). However, the announcement had no perceptible impact on the structure (or direction) of SNA since it was used almost exclusively as a 3790 replacement (using the DPCX operating system).

- The predominant GST trends do not necessarily represent the apparent industry direction in any area at any particular time. In other words, both IBM and the computer services industry are not necessarily addressing what must happen next. (Some of IBM's "solutions" address yesterday's problems, and others are premature because of lack of progress in related areas.) Indeed, the relative GST trends may shift emphasis in order to compensate for "abnormal" directions (activities) in systems development.

- Therefore, the GST predominant software trends identified in Exhibit IV-12 may be viewed as INPUT's best judgment as to the general systems reaction to specific IBM directives and industry activities at this particular time. The view that has been adopted is at a macro level and addresses a technological environment characterized primarily by the application and adaptation of microprocessors to new and existing systems.

o With these qualifications in mind, the lower levels of the IBM software pyramid have these characteristics:

- IBM's announcement of DB2 indicated a clear direction toward integration of data base systems that would make central data base systems, local data base systems, and personal data bases interdependent (see Exhibit IV-10). This direction (and that of generalized data base systems) appears to run counter to a perceived, inevitable trend toward highly specialized and mechanized data base systems. The conclusion that the predominant trend for DBMSs will be Progressive Mechanization was reached for the following reasons:

. The immediate need for performance improvement of general purpose DBMSs (especially with the implementation of IBM's highly integrated approach) will require hardware implementation of specific DBMS functions.

. The ultimate implementation of expert systems will result in such close integration of hardware/software/knowledge that specialized "solutions" will evolve.

. Optical disk technology, coupled with intelligent workstations will result in distribution of information bases with specific hardware/software to use the information base. (Distribution of the Encylopedia Britannica or any published reference work on optical disks is an example.)

- IBM's apparent direction in languages is to control the inevitable differentiation so that various user-oriented languages may be integrated under IBM's DBMS and operating systems. It is INPUT's opinion that the predominant GST trend of Progressive Differentiation in languages cannot be slowed (nor will it be severely affected by the parallel trend toward standardization and mechanization), even if that were desirable.

- Decision support systems represent the current manifestation of a long struggle to extend human intellect through the use of computer technology.

. Regardless of how decision support systems are defined, IBM's primary objective is, and will remain, to integrate them with existing IBM operating systems, data base systems, and languages.

. Because the decision making process is highly personalized (even within specific industries, professions, and organizations), it is INPUT's opinion that Progressive Integration, Differentiation, and Mechanization will proceed roughly in parallel as solutions are applied before the problem is fully understood. (This is not meant in any derogatory sense; trial and error is sometimes the only way to make progress.)

- Resuming our trip down the IBM software pyramid, industry turnkey systems (by our definition) represent important business opportunities for IBM and they are central to IBM's long-range strategy.

  . Industry differentiation is the only IBM software direction that is of equal significance with IBM's current predominant directions of integration and centralization; all three trends are procedures in parallel and with equal emphasis.

  . The IBM INS/IVAN project serves as a useful prototype of the macro approach to achieving IBM's objective through network integration, industry differentiation, and central control through data and software standardization.

  . The predominant GST trend of Progressive Integration is clear with regard to the vertical applications that must develop in a distributed processing environment, and also with respect to where office systems and data processing systems must meet.

  . The GST trend toward Progressive Mechanization is already apparent in terms of retail transaction credit systems and networked automatic teller machines.

- IBM's overall software strategy of integration and highly centralized control, as demonstrated in this report, has perhaps led to its benign

neglect (and lack of success) in the development of applications packages. All of the "exciting work" in operating systems, DBMSs, languages, decision support systems, and industry turnkey systems contribute to the general attitude that specific applications aren't really too important, and will eventually go away. The user IS departments have adopted the same attitude and have been unable to service relatively simple user applications requests as they pursue the latest solution to the problems associated with building, maintaining, and accessing corporate data bases.

. Therefore, information centers and prototypes are encouraged by IBM as the means of developing routine applications as long as they are integrated with and depend upon the general-purpose software being developed at higher levels.

. The predominant GST trend during a period when both computer power and systems development (installation) responsibility is being distributed and delegated to end users must be Progressive Differentiation of application packages.

- Although both IBM and some of its major clients have had unpleasant experiences with the Big Bang Theory of data base development, the tendency seems to be carrying over into the predominant approach IBM is taking in the development of data/information/knowledge-based systems.

. Essentially, IBM is adopting the concept of enormous data/information depositories that can be used to create and control subordinate data/information bases and serve as the foundation for decision support systems that will evolve into knowledge-based systems.

- This is a top-down approach, as opposed to the predominant GST trend of Progressive Differentiation, which implies a bottom-up approach by selecting a more specialized subset of the data/information/knowledge base.

o The contrast between IBM's software directions and the predominant GST trends, which have been defined by INPUT, must be reconciled over time. This adjustment can be done either by IBM's adjustment of its own direction in various areas, or by a general shift in predominant GST trends because of a changed technological environment (which could conceivably be caused or controlled by IBM).

V

V ANALYSIS AND CONCLUSIONS

A. IBM's STRENGTHS AND WEAKNESSES

- IBM's strengths are obvious:

  - IBM has enormous financial strength.

  - It recognizes the importance of software to its general business success in hardware sales.

  - It has invested substantial resources, continues to invest (at an increased rate) in software development, and gives every indication that this investment is being given special attention by IBM management.

  - IBM's general software strategy of highly centralized systems has been successful in establishing general technological, leadership, and account control of the customer base.

  - This strategy of centralized systems has placed IBM in an extremely strong position to control major computer/communications network trends and to penetrate lower levels of the software pyramid.

  - IBM has the necessary support systems to facilitate rapid growth in software sales through established distribution channels and maintenance service.

- IBM has a valuable pool of executive talent that will permit it to expand through internal growth and various external arrangements (joint ventures, marketing agreements, acquisitions, etc.)

o To the degree that past IBM success has been achieved at the expense of substantial deviations from the dictated trends of GST, weaknesses have been built into the general IBM software systems structure. Continued success merely means that inevitable adjustment will be more difficult.

o Simply stated, the weaknesses built into the IBM software structure are as follows:

- The basic objective of the IBM software strategy has been to promote hardware sales and installation, and to exercise control over the IBM customer base. Regardless of how much lip service is paid to ease of use, addressing the customers' specific business requirements has been of secondary importance.

- As a result of abnormal emphasis upon Progressive Centralization, an exceptionally complex system has evolved. This system is not only difficult to use (and to understand), but it forces the user to adopt complex solutions to problems. Indeed, IBM encourages complexity through promotion of analysis tools such as its Business Systems Planning (BSP) and Business Information Control Studies (BICS).

- Given a fundamentally complex system to begin with, IBM's use of systems software to force hardware obsolescence has created an operating environment that can only be described as chaotic. Over the last twenty years, IBM customers have been forced to apply their most skilled systems personnel in a continuing struggle to keep up with a constantly changing hardware/software environment. (In addition, there has sprung up a whole generation of mobile systems personnel,

more interested in becoming MVS, CICS, or IMS experts than they are in solving their employer's problems.)

- Despite improvements in hardware price-performance, the true cost of the IBM hardware/software systems "solution" is frequently prohibitive for many advanced applications. The promised cost-effective solutions always seem to be waiting for the next generation of IBM systems.

o The fundamental problems associated with systems complexity and price/performance also have adverse effects upon IBM management of the systems development function and, indirectly, upon the strength of IBM executive talent in certain environments. Because of IBM's experience with software development, and its success in achieving IBM's business objectives, certain misperceptions have developed within the IBM management structure:

- The first is that software systems, of necessity, must be complex, costly, and perform poorly (or at least it appears that customers want or accept such systems).

- Second, and more important, IBM has become convinced that it knows better than the customer what is needed to run the customer's business.

- Last, but not least, there is the ultimate delusion that IBM software systems are the answer, and that no one could possibly develop comparable systems without comparable investment of resources (which no competitor obviously has).

o To the degree that IBM meets its general business objectives in terms of revenue and profit, the underlying software strategy will be deemed successful and, therefore, it may even be presumed to be technically correct. This, in turn, will have the following results:

- IBM will be less likely to make major changes in software directions.

- As long as IBM can meet revenue and profit objectives through the current hardware/software/services mix, the less likely it will be to adopt more aggressive efforts to penetrate lower levels of the software pyramid.

- The system software specialists will remain an integral part of large information systems organizations.

B. THE REALLY BIG PICTURE

o INPUT believes there will be four critical software strategic periods for IBM between now and the end of the century, as shown in Exhibit V-1. While all four will overlap and proceed in parallel, the significant periods are distinguished by their contribution to IBM's growth and profit requirements and by the IBM product/service strategy being supported. These four periods are defined as follows:

- The SNA/DDP period, which is characterized by the following:

  . The software strategy will continue to be the centralized approach described in Chapter IV of this report.

  . The major revenue producers will continue to be conventional mainframes and associated peripherals.

  . The major growth areas in terms of increased revenue dollars will be magnetic disk storage and intelligent workstations.

  . The major new software source of revenue will be general programs to support intelligent workstations.

- The Electronic Office period, which will be characterized by the following:

  . The software emphasis will shift to a more specialized industry orientation at the applications level.

  . The major growth area will be a new set of integrated office systems (processors, storage, and workstations), which will make current systems and conventional office products obsolete.

  . The new software area will be industry- and professional-specialized systems that will reduce the expense of document processing and paper handling.

- The Expert Systems period will be characterized by the following:

  . The major software direction will be toward the integration of interorganizational systems through interconnected private and public networks.

  . The major revenue producer will continue to be integrated office systems plus the communications systems and services to support interconnection.

  . The major growth area will be service to supply supplementary data and information support to users of the interconnected network. Such services will include: data collection services, backup processing facilities, certified data base storage, etc.

  . The major new software area will be access services to proprietary data, information, and knowledge bases.

- The Custom Products and Service period will be characterized by the following:

  . The major software direction will be toward customized services to individuals, both at home and in the office.

  . "Subscriptions" for data/information/knowledge will result in highly customized and packaged hardware/software/service for individuals and organizations.

  . The primary revenue source will become the software/service portion of the subscription, rather than the necessary hardware. (Just as telephone service costs substantially more than communications equipment.)

  . The fastest growing software area will be knowledge-based systems necessary for individuals and organizations to survive in the information age--from teaching Johnny to read to permitting retired people to participate in the interactive "entertainment" that will replace computer games.

o The strategic periods should not be viewed as beginning and ending abruptly. Fundamentally, they represent the pronounced shift of emphasis required to meet IBM's growth objectives.

o IBM's prevailing software directions will gradually shift over the strategic periods:

  - Centralization will continue to predominate during the SNA/DDP period.

  - Integration will become the most important direction during the Electronic Office period as LANs continue to become more dependent upon

central data bases; communications, computer, and manual systems become more closely integrated; and workstations (and their operators) become more interdependent.

- Differentiation will become predominant during the Expert Systems period as specialized interorganizational networks develop, based on data standards, information requirements, shared professional interests, or language/information preferences of users.

- Ultimately differentiation will give way to progressive mechanization, which will mean emphasis upon custom products and services during the CPS period--individuals will receive information and systems (programs) tailored to their personal and hardware requirements.

- At this point, it is once again necessary to emphasize that all of the GST trends proceed in parallel, and that relative emphasis is based upon the changing environment (specifically the computer/communications technological environment). IBM's business plan is an effort to control this environment and meet growth objectives, but the paradox associated with this can now be seen--in order to meet its growth objectives IBM must ultimately satisfy the GST requirements by adjusting its software directions and emphasis over time.

- It is apparent that IBM's growth rate for software/information must be substantially higher than that for its corporate strategic plan. General observations concerning the sources of such growth are as follows:

  . During the SNA/DDP period, mainframe-oriented software will proliferate at the nodes--down to the intelligent workstations where sheer volume will dictate significant growth.

  . During the Electronic Office period, the emphasis upon integrated systems will see IBM enhancing its normal hardware/software products.

- During the Expert Systems period the shift to specialized networks incorporating data/information/knowledge will emphasize the trend away from generalized solutions (in terms of networks, operation systems, languages, etc.) and toward specific solutions to the specific user's problems.

- The Custom Products period will facilitate the individual's pursuit of knowledge, information, and entertainment.

o There are obviously factors working for and against IBM in the achievement of its growth objectives during each strategic period. However, one preliminary conclusion of importance is that IBM's success is heavily dependent upon outside software vendors--especially in the last two strategic periods. This will add complexity to IS management. IS may have to deal through IBM to support products and systems produced by other vendors. In fact, IBM may be viewed as an OEM in these later periods and must be treated as such when these systems are acquired.

C. CHALLENGES AND OPPORTUNITIES

1. THE SNA/DISTRIBUTED DATA PROCESSING PERIOD

o It is anticipated that IBM will be successful in meeting its revenue objectives during this period within the general framework of its software strategy. This does not mean that substantial technical and financial problems with the strategy will not become apparent to IBM customers during this period.

o Exhibit V-2 summarizes IBM dependencies and challenges during the SNA/DDP period, and presents the divergence between IBM software directions and predominant GST trends.

o IBM's dependency on highly centralized software, large processors, data bases, and magnetic disk storage has been analyzed earlier in the report. The challenges IBM faces during the SNA/DDP period are directly related to these dependencies.

- The early development of erasable optical memories with an order of magnitude reduction in the cost of on-line storage could be a substantial challenge to IBM since it is heavily dependent upon increased revenue from magnetic disk storage. INPUT has analyzed optical memory technology in detail, and concluded that IBM will be able to control acceptance of optical memory until the late 1980s and ensure its revenue from magnetic disk through the decade. (See INPUT's Impact of Upcoming Optical Memory Systems, April 1983.)

- The continuing threat of minicomputers in the processing hierarchy is well understood by IBM, and its strategy during the SNA/DDP period will be to put as much pressure as possible on such systems. IBM's version of the processing hierarchy is depicted in Exhibit V-4. It is INPUT's opinion that IBM will be successful in meeting its objectives with this strategy.

- The entropy (as defined in Section IV) associated with data/information/knowledge is not currently understood by systems designers or software developers--it is an area requiring substantial research. However, there can be little question that problems--to the extent that they do exist--will inevitably surface in the IBM processing hierarchy depicted in Exhibit V-3. These problems will be manifested in the energy (cost) required to maintain data/information/knowledge quality in an environment with increased potential for disorder.

- IBM has satisfied itself that its distributed processing hierarchy will not result in the demise of the large mainframe but will, in fact, result

in increased demands upon the large processors. INPUT agrees with this assissment. However, the production of "MIPS on schedule" to meet these demands is now in question for the following reasons: 1) IBM has slowed research on Josephson functions (causing a technical reorientation), 2) Trilogy, after repeatedly delaying its delivery schedules, cancelled its very large scale IBM-software-compatible system, and 3) the demand for MIPS at various levels in the processing hierarchy is interdependent and extremely difficult to predict. All of the above complicate the traditional "scheduling of inventions" that has been built into the IBM planning process.

- The difficulty of "scheduling inventions," the impossiblity of accurate performance prediction in IBM's complex hardware/software/ communications environment under SNA, and the high entropy of data/information/knowledge in this environment, all lead INPUT to conclude that software-induced performance catastrophies are inevitable during the 1980s. The only question is the frequency and level of such catastrophies.

  . Most certainly, numerous systems developed for intelligent workstations will fail because of performance and/or cost problems at various levels in the hierarchy.

  . Significant numbers of major corporate systems dependent upon large central data bases and SNA-distributed processing will encounter the same problems and be abandoned either before or after their completion.

  . Some systems will continue to run for extended periods while data degenerates to the point where the investment in the information system must be written off.

. However, the real danger is that the combined problems of performance/cost and entropy of data/information/knowledge may go undetected (or be denied) until the enterprise itself fails.

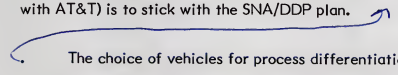
. Regardless of whether IBM has legal liability in these catastrophies, it is in IBM's best business interests to see that the frequency and magnitude of such failures are contained, but this will be more difficult than it has in the past.

. The difficulty is that it may be beyond IBM's technical ability to "make it work" or "make it right," and the fact that this has rarely happened before (because of success of the software strategy) only makes this challenge especially troublesome (and unanticipated) for IBM management.

o The critical challenges facing IBM during the SNA/DDP period are all related to IBM's attempt to control the release and direction of new technology that will affect its primary revenue sources: mainframes and peripherals.

- The relative economics of the processing hierarchy have forced IBM to emphasize integration in the process function of operating systems (see Exhibit V-2), while all of the other functional areas continue to demonstrate progressive centralization. A good example of such integration is IBM's agreement with Computervision for development of a CAE/CAD/CAM system to run under VM using SQL on IBM 43XX systems with UNIX being used at the intelligent workstation level. (This particular agreement is highly indicative of IBM's general strategy vis-a-vis minicomputers, UNIX, and cooperation with systems integrators in pursuit of broader goals--hardware sales.) The Computervision system has been differentiated from the large, general-purpose host mainframe as a specialized system that IBM, in turn, integrated under its greater operating systems umbrella. Observations concerning process differentiation are as follows:

- The normal vehicles for off-loading specialized applications have been minicomputers, but IBM's strategy (even in view of the battle looming with AT&T) is to stick with the SNA/DDP plan.



- The choice of vehicles for process differentiation can be among mainframes (43XX), minicomputers, and/or intelligent workstation--IBM's preference is obvious.

o In storage management, both IBM emphasis and the predominant GST trend are the same--Progressive Centralization. Here it is important to make one significant distinction--the fact that the storage management function is centralized does not mean that physical storage must be centralized. The fact that centralized storage management is the right emphasis does not mean that such management will necessarily encourage the efficient use of storage.

- As storage costs become an increasing percentage of DP budgets, systems that facilitate (or encourage) more efficient use of storage will become increasingly attractive. The need will arise for everything from efficient compression algorithms for image storage up to accounting, reporting, and forecasting facilities to permit management of storage costs.

- In addition, some IBM systems encourage (and even dictate) using disk storage as an electronic waste basket that seldom (if ever) gets emptied (and, under centralized management these wastebaskets will probably be backed up at central facilities). Improvements must be made to these systems and IBM is unlikely to do anything to seriously affect revenue from magnetic storage during the 1980s. IS managers must develop storage control procedures or continue to increase their budgets in this area.

- Protection and security is viewed by IBM as an enormous market opportunity. The global solution that will probably be attempted under IBM's highly centralized approach will encourage enormous waste of processing, storage, and human resources. (It is not difficult to envision the electronic wastebasket being encrypted as it is transmitted to a backup node for permanent storage.) The entire area needs special attention at all levels in the network on both an applications and a global basis.

- As discussed earlier in the report, resource allocation is a complex problem that has suffered from malignant neglect on the part of IBM as operating systems (and their associated subsystems) have created an ever-increasing demand for processing power. This neglect has been manifested by resistance to the performance measurement necessary to understand and improve resource allocation (except for collecting of operating statistics at substantial systems overhead). If INPUT is correct in assuming that catastrophic system performance failures will occur with increasing regularity as the 1980s progress, there is a great need for improvement of systems resource allocation.

  - Specifically, there is an immediate need for host systems that incorporate analysis and screening of data requests from intelligent workstations in order to issue warnings and/or reject requests that may seriously affect host performance (or even cause failure).

  - In addition, advanced network modeling techniques to ensure optimum (or at least acceptable) processing and data distribution are required in order to facilitate network planning and resource allocation.

  - IBM's concentration upon the host problems that are being created by IBM's SNA/DDP strategy leaves a product void that must filled either by non-IBM vendors or extensive commitment of IS programming resources.

o The issue of systems structure was identified earlier in this report as being an issue in which IBM's direction of continued centralization is clearly apparent in the emphasis upon VM as the new "leading part" to maintain control. IBM's mainstream MVS/XA, competitive operating systems such as UNIX, and any specialized operating systems that may develop in the future (at any level in the hierarchy) can theoretically be integrated as virtual machines. This is sound strategy. At the same time, the state of technology dictates isolation and mechanization of specific operating systems functions. This will range from special-purpose operating systems running as virtual machine to personalized cells within a central array of microprocessors (for resource allocation, security protection, etc.).

- The possibility of restructuring operating systems through mechanization led INPUT to include a special hardware/firmware/ software area under operating systems. As pointed out previously, it is INPUT's conclusion that IBM's disenchantment with the general layered approach to systems structure represented by FS will probably preclude aggressive pursuit of a hardware/software/firmware strategy on IBM's part. This could lead to a restructuring of current operating systems functions implemented in mainframe software, specifically:

  . Specialized data base machines will succeed provided they do not err in trying to duplicate other mainfame functions.

  . Special processors to off-load resource allocation, security-protection functions, and performance monitoring are also possible.

  . As pointed out previously, it makes little difference whether the processors are separate or hidden under the covers--many operating systems functions are long past due for mechanization.

- Since large IBM processors are typically required only to perform such functions (run IBM systems software), large IBM processors may indeed become extinct--it is all a question of timing.

- INPUT believes that large-scale IBM operating systems will survive through the SNA/DDP period thanks to IBM marketing strength and some useful assists from those that intelligently off-load some of the central software burden for IBM.

o In the area of DBMSs, the development of data base machines (incorporating the file-access and language processing functions) is an obvious example of the mechanization of functions previously left for software implementations. However, there are other possibilities for mechanization while IBM remains in a posture of integrating various data base models and file structure. (See Exhibit IV-10.) These include:

  - The early recognition that optical disks have an important role to play in data base systems prior to the time that erasable media are generally available presents a significant ~~possibility~~ opportunity for realizing storage costs. Specifically, DBMSs could incorporate optical disks for:

    - Archival storage of standard reports.

    - Backup of magnetic disk data bases, (in lieu of magnetic tape).

    - On-line storage of very large data bases, including archival sequential files currently on tape. (Optical disk will also make the electronic wastebasket concept practical.)

    - Bridging between on-line date bases and information sources currently on micrographic media.

- The ability to keep all documents economically on-line will result in the need for information management systems substantially more flexible than those employed for current DBMSs that deal with encoded data. Data models to facilitate browsing rapidly through files may require document extracts, surrogate data bases (to permit rapid searching on key words, phrases, or even patterns), information lexicons associated with various professions and occupations, and information classification and retrieval schemes well beyond those employed in current DBMSs or library systems.

- Image-processing systems to permit mechanized updating of encoded data bases from documents (using pattern recognition) and management of the resulting magnetic disk data bases and optical disk document files represent an important opportunity for systems integrators.

- IBM's integrated data base environment (as depicted earlier in Exhibit IV-10) has high potential for placing excessive processing burdens on even the largest mainframe. Data base performance monitors to estimate the cost of joining two large relational tables or the cost of using DXT to create relational tables from archival flies should become not only popular but necessary once DB2 is installed on large mainframes under MVS/XA.

- In addition, it appears that IBM's integrated approach will initially provide only the most rudimentary approach to distributed data bases, with everything being a slave to the host. There is a significant need for data base systems that can locate data between, and among, workstations (nodal processors) and host systems. (See INPUT's report Micro-to-Mainframe End User and Telecommunication.)

o It is INPUT's opinion that the trend will be away from general-purpose decision support systems. Differentiation by industry, profession, and occupational categories is necessary at the present time, and this will soon give way

to another level of differentiation: expert systems. These systems will require the development of specific knowledge bases, decision trees, and payoff matrices within narrow areas of expertise--in other words a lot of work. The progress of these systems will be limited only by imagination and the availabilities of skilled system personnel to develop such systems, but certain specific tools and products are needed:

- Languages tailored to specific expert areas will become necessary, and INPUT does not believe INTELLECT is the answer to all of these requirements. INTELLECT is too general.

- Tools to assist systems analysts in the development and implementation of expert systems are necessary, and INPUT does not believe that LISP machines are necessarily the answer to all of these problems. In some cases they represent overkill, and in others they fail to incorporate appropriate interfaces to knowledge bases.

- The development of new decision support models incorporating more recent developments in mathematics such as catastrophe theory and fuzzy-set theory are all going to be essential. INPUT does not believe it is either necessary or desirable to leave all such advanced work up to the academic community (or the emerging Artificial Intelligence companies).

o Industry turnkey systems are the most complex area to analyze at this time because of IBM's traditional industry emphasis and because of the importance of such systems in IBM's Electronic Office period, which will follow. IBM's activity in this area was reviewed earlier, and several things occurred as the report was being completed:

- F.G. Rodgers, IBM's vice president of marketing, in a speech before the Independent Computer Consultants Association, stated that IBM plans to concentrate future product development and sales efforts on hard-

ware/software combination packages. The products were stated to be "strictly designed for the end user and will be clearly applications oriented." Although the specific market segments were not revealed, it was stated that vertical markets such as insurance, banking, and financial services would be targeted. Banking applications are already being offered.

- It is INPUT's opinion that despite much talk about integrated voice, image, text, and data systems (Rodgers mentioned this again in his speech), IBM's integrated electronic office efforts will be slow during the 1980s. Major industry segments will need software assistance in employing new technology in the office before IBM is prepared to launch the Electronic Office strategic period of the early 1990s. Specifically:

  . Integrated digital LANs supporting voice, data, images, and text can and will be constructed today--they require applications (and systems) software to support the new workstations and devices that will permit the mechanization of the current manual systems that exist in various industries.

  . The new hardware (which IBM will be slow to support) involves the scanners, optical memories, and high-resolution CRTs that are necessary to reduce paper in the office.

  . Hardware systems integrators are developing such "electronic filing systems" now--they need software help, especially at the industry applications level (and so will their customers).

- Industry turnkey systems represent the culmination of the needs that ~~have been presented for~~ what exist at the higher levels of the software pyramid (operating systems, DBMSs, and DSSs).

- o New applications packages designed for today's environment, in which intelligent workstations should be off-loading the mainframe, present both a challenge and an oportunity to the software industry.

- o There is a need for applications packages that are designed for the workstation and that incorporate necessary host services as required. This is contrary to the concept of splitting off minor functions, such as report generation, from the host. IBM is currently more interested in integrating distributed processing under the large host system than it is in off-loading significant user applications to either minicomputers or intelligent workstations. (Distribution of processing at the expense of large host off-loading will come slowly from IBM even during the SNA/DDP strategic period.)

  - However, the revenue potential of software packages for standalone PCs (even if only temporarily disconnected from the host) is apparent to IBM, and IBM's direction was clearly stated by Rodgers: "We're changing, as you can probably see. We are changing our methods of distribution. We want to be the low-cost producer as well as the low-cost seller, which is a bit of a challenge for us." IBM's recent announcement of low-cost PC packages ($149.00 and below) indicates clearly that IBM intends to be a low-cost mass distributor in at least certain areas.

  - The low-cost method of production, from IBM's point of view, was also disclosed by Rodgers when he stated that IBM is "working with software people around the world" to produce the software packages IBM requires and "is willing to enter into royalty agreements." IBM intends to become the world's largest supplier (distributor) of software for personal computers, and it also will be the world's biggest customer for independent software suppliers.

- o While data/information/knowledge have been combined as a single software level, they present different needs.

- IBM's centralized approach to data management has been explained, and numerous needs for improvement have been presented for higher levels of the software pyramid. However, it should also be recognized that the operator of the intelligent workstation is "buying" data from the central facility; the availability, quality, and cost of these data may not be satisfactory. The intelligent workstation provides freedom to the user to seek necessary data from outside sources.

  . As more intelligent workstations have access to private and public networks, the demand for specialized data bases will grow rapidly.

  . Many of these data bases will represent requirements that are currently satisfied through reference works in libraries; individual companies will find it impractical to install and maintain such data bases.

- Information services have many of the same attributes (and opportunities) as data, but the value added is potentially much higher. An interesting phenomenon has developed because of the proliferation of books about personal computers (and associated software)--the distributors are at a complete loss to determine quality. The only recommendation that has been made is to rely upon well-known authors and publishers. This example is instructive from several points of view:

  . Increased volume of "information" on any particular subject tends to increase noise and lead to chaos, requiring increased effort (energy) to maintain quality.

  . Quality information will be in demand, but the inability to discriminate will lead to reliance upon established sources. The analysis and evaluation of information (and information sources)

will be in high demand, and electronic systems are ideally suited to provide such information services.

- Imaginative software to navigate through information sources is going to be required (whether it substitutes for the "fingers doing the walking through the yellow pages"; ties together dictionaries, thesauri, Bartlett's Quotations, and Fowler's Modern English Usage; or assists in identifying appropriate personal computer software).

o Knowledge bases have all of the attributes of both data and infomation bases, except that there is the requirement for continuing added value. In other words, knowledge bases require continuing maintenance and improvement if they are to remain useful--and if liability is to be avoided. Knowledge bases and the expert systems that will be built incorporating them are inextricably integrated with the end user(s). The ramifications of combining the human "information engine" with expert systems is not understood, but the potential for failure of such systems is extraordinarily high.

- It is INPUT's opinion that the future challenge in knowledge-based systems will be not so much in making them easy to use but in making them understandable and therefore truly useful.

- Knowledge is currently contained in human brains and frozen in paper--there are virtually unlimited opportunities to improve on this situation, and even (or perhaps, especially) the smallest companies and individuals can make substantial contributions to the knowledge base.

o There are extremely complex interactions among data/information/ knowledge, computer systems, and human beings. The scientific and philosophical considerations can no longer be ignored--today's systems must be developed with a better understanding of these interactions because even more drastic changes are going to occur in later strategic periods.

2. THE ELECTRONIC OFFICE PERIOD (1990-1995)

o As the range of prediction gets longer, the picture becomes less clear, but the Electronic Office period will truly test IBM with some new challenges. It will be a period when software first becomes critical to strategy, communications become more important than processing, and there is the potential for significant sales resistance to IBM's strategy. It is indeed a critical period for IBM--while the previous period's goals were realistic and the next period's may appear fanciful--it is going to require not only hard work but maybe a little luck. Exhibit V-4 outlines the scenario.

- IBM's strategy depends upon one thing at which it is the acknowledged master, and four things that it normally prefers to avoid.

  . The area of expertise is in obsoleting its hardware line, but even here there is a noticable environmental change--the replacement will occur in the office for all to see and not in the cloistered environment of the computer room.

  . The electronic office is dependent on a dramatic increase in capability and a decrease in cost of optical memories. The impact on magnetic disks will have to be carefully managed--IBM does not like shifts of technology against established revenue producers.

  . IBM is aware of the problems with software development, and (as mentioned previously) is already starting to talk about an integrated software/hardware strategy--six to seven years should be ample lead time for turnkey systems, but IBM is always wary of major software efforts, especially in the applications area.

- Major benefits of electronic offices are lost if paper is still used for interoffice communications. IBM has recently been granted the right to make joint presentations with SBS, but a strategic dependency such as interoffice communications cannot be left to an arm's-length relationship. In addition to labor problems, communication services raise the specter of regulation, but IBM must proceed--the next strategic period will see them heavily in the communications business.

- Even though software, communications, and new technology (outside of IBM's control) are not popular with IBM, nevertheless IBM appears to be preparing to address these dependencies of the Electronic Office period.

- The challenges for IBM during this period are more apparent than some of the unpleasant surprises that IBM will probably encounter during the SNA/DDP period. They all center around timing and account control, and IBM is very sensitive to such issues. Fundamentally these challenges are as follows:

  - Competitive software will be encountered in industries that IBM targets for penetration and IBM's reputation as a provider of applications software has not been good.

  - Network management has not been an IBM strength and both LANs and interoffice communications will see IBM challenged by respected competitors among the common carriers and VANs.

  - Because of IBM's slow pace in integrated office systems, it is inevitable that working systems will be in place that do at least as much as IBM systems will when they are announced (this will be especially true in image processing). Such systems are not easily replaced.

- During this period IBM will be faced with a major operating systems change (remember, IBM projected that XA would run out of capacity in the late 1980s). The challenge will be to change from the highly centralized design philosophy of the past, and to provide a vehicle that will permit the integration necessary (from IBM's point of view) during this period.

- Last, but not least, there may be substantial customer resistance to getting rid of paper-based systems and procedures--especially since such a move would be seen as giving up the "freedom" of personal computers to the technocracy again. The integrated office is going to bind the operator to the workstation the way the assembly line tied the blue collar worker to the machine ("time and motion studies" will be inherent in the system), and white collar workers may not be ready when IBM tells them they should be.

o The implications of the Electronic Office period will frequently be an extension of those in the earlier period. In some ways, this will be a period of maximum synergy between IBM and competitive software vendors. IBM will be in a period where integration will be emphasized, and will just be becoming heavily dependent upon software. The dominant GST trend will be toward Progressive Differentiation of newly integrated office systems in order to accommodate specific working environments required (or desired). IBM will need assistance in installing major systems.

- The detailed breakout of operating systems functions for the SNA/DDP period has been eliminated for this strategic period. These functions applied to the large-host mainframe era signified by MVS/XA, and the importance of such general-purpose systems will have diminished. The opportunities for operating systems improvement will be in their twilight since INPUT predicts that IBM will be in the process of a

major operating systems revision during the Electronic Office period. The largest need in this period will be for communications-oriented operating systems in the electronic office. Comments are as follows:

- It is probably that whatever operating system IBM develops for the office will inherit genetic deficiencies from MVS/XA.

- It is convenient (and perhaps necessary) to view an electronic office as a communications network with classical data processing (as well as document handling) as mere incidentals.

- Operating systems that recognize that the majority of office "work" is communications will be designed quite differently from those that were originally designed to replace adding machines on accountants' desks.

- It should also be pointed out here that operating systems originally designed to replace electromechanical calculators on engineers' desks (such as UNIX) are not the solution, even though these systems communicated with the timeshared processor.

- The major characteristic of such communications-oriented operating systems will be the elimination of a single leading part in favor of interacting parts.

- The needs in DBMSs will continue as a direct extension of those previously discussed for the SNA/DDP period. The requirements for the managment of data, information, and knowledge are interrelated--but different. Progress from data to information to knowledge-based systems will require new concepts in data/information/knowledge structuring and support of new technology to facilitate storage, access, and distribution.

- Work in languages and decision support systems during the earlier SNA/DDP period will be critical to development of the early expert systems that will begin to emerge during the Electronic Office period. The GST term Progressive Mechanization is applied because the bringing together of necessary data/information/knowledge and programs (at the specific workstation, for the specific operator, at a particular point in time) effectively specifies a single function that is to be performed. This aspect of expert systems applies regardless of whether the workstation is being used for routine claims processing in an insurance company, for the translation of Chinese literature, or for reviewing the compensation plans of IBM executives.

- IBM may be starting now to plan combined hardware/software offerings by industry, but IBM has also acknowledged that it is seeking help from "all over the world" in software development. The primary revenue dependency during this period is on the installation of new hardware in the office. It is doubtful that IBM turnkey systems will be universally acceptable, and IBM will continue to be in the market for application software that makes effective use of IBM's new hardware. Careful selection of industry systems for integration and mechanization during the SNA/DDP period will provide systems vendors with an opportunity to be of "assistance" to IBM in the Electronic Office period.

- The integration of voice, data, images, and full video in electronic offices makes the current paper-based computer applications obsolete. Work on the new applications can start during the SNA/DDP period. Imaginative use of optical disks alone represents major new application opportunities.

- The development of data/information/knowledge bases will become the cornerstone of applications as far as we can see into the future. The discussion under the SNA/DDP period continues to apply, and the demand for data/information/knowledge bases will explode once the

integrated electronic offices of the Electronic Office period become interconnected during the Expert Systems period, which follows.

3. THE EXPERT SYSTEMS PERIOD (1996-2000)

o The Expert Systems period is over 10 years off, but IBM is already working on a major system that can serve as a prototype for analysis. We refer to the previously mentioned joint effort (IVANS) between IBM's Information Network Service and the Insurance Institute for Research. While it is reported that IBM is somewhat frustrated with the progress (and profitability) of IVANS, nevertheless IVANS is probably the most important strategic development effort IBM has underway—IBM is developing an archetype for the future. A living scenario will serve to illustrate the point:

- IVANS ties together a consortium of property and casualty insurance companies with independent insurance agents. Assuming IVANS is successful, it will become a standard for the industry and INS will pick up the communications services for the industry.

- IBM, in turn, could be in an excellent position to influence hardware and software in that industry.

- The IVANS model can also serve to link medical insurance organizations with hospitals and employers. Then, of course, financial institutions could be added to facilitate funds transfer. Information and knowledge bases for medical research and medical expert systems would be a natural fallout.

- IBM would be at the center of all this, and while the scenario is general in nature, it is illustrative of the importance of the Expert Systems period to IBM.

o The shift from hardware to software was gradual, but the dependence upon data/information/knowledge will come relatively abruptly to IBM in the Expert Systems period, as shown in Exhibit V-5. IBM's product and service offerings will be distinguished by Progressive Differentiation during this period, but it is something of a paradox that standardization of data (information and knowledge) elements and definitions within these specialized areas will be prerequisite for this differentiation. (As mentioned previously, IBM is investing substantial systems analysis resources in the IVANS project and the main focus is on standardization.) A summary of IBM dependencies is as follows:

- Increased revenues from software and services will be the key to IBM growth during this period. During 1990s, IBM must create a software business that will exceed its total size at the beginning of the decade ($100 billion).

- IBM must assume responsiblity for running a highly reliable, responsive, secure network (INS or its successor), and must provide the hardware/software technology for its clients to do the same. This is going to be the true IBM-AT&T battle.

- Data/Information/Knowledge bases on the network will be the attraction for new customers (as illustrated in the IVANS scenario presented previously).

- There is currently no model for the management of an organization as large as the one IBM will become in the late 1990s. The management challenge will be to maintain organizational flexibilities and integrity during this period. In order to be successful, IBM must develop internal information systems to meet the challenge. To a large extent, IBM's success depends upon its product--it must be on the leading edge of advanced information systems development in order to manage its own growth!

o The challenges IBM faces during the Expert Systems period are as follows:

- While systems development in a programming sense is a problem, standardization of data/information/knowledge represents a much more tedious and thankless task that is nonetheless essential for rapid expansion of products and services during this period. If the magnitude of the problem is not recognized early it could be critical. IBM is familiar with many of these problems from its own internal systems experience, and it may recognize that dictating hardware (and even software) standards does not solve the data problem.

- The challenge of assuring that appropriate data/information/knowledge bases are available as required is related to the standardization problem, but it goes deeper than that. IBM is well aware of the problem of providing hardware/software "solutions" and then finding the data base is inadequate--the history of management information systems is replete with examples. However, during the Expert Systems period IBM must take the initiative in assuring that the shared data bases are available.

- IBM is a master at pricing products and services, but some of the new products (Expert Systems) and services (access to data/information/knowledge bases) will be a challenge even for IBM. In fact, IBM may lose some control.

- The challenge of regulation--either how to avoid it, or how to adjust to it--is going to arise during the 1990s for IBM. AT&T will be sure to see that the issue is raised regardless of how careful IBM is in navigating the swamp. The whole question of what constitutes computer services and what constitutes communications services isn't getting any clearer despite past inquires and rulings. Congress and the FCC will return to the regulatory arena with renewed vigor after the current deregulation respite.

- As mentioned under dependencies, IBM is dependent upon its own products to maintain the organizational and management flexibility and integrity necessary to achieve growth. If IBM succeeds, the Federal Systems Division may become IBM's biggest growth area--imagine a facilities management contract with all of Health and Human Services.

o The implications for IS during the Expert Systems period will be primarily dependent upon the availability of IBM products and services, and on IBM's requirements for additional software products and services for IBM clients. The general rule will be to mechanize while IBM is differentiating. Specifically:

- Operating systems will tend to be integrated with hardware embedded in both LANs and the supporting public and private interconnect networks. IBM will still be busy integrating the old software operating systems that were oriented toward data processing. The hardware/software/firmware requirements that started with backend data base machines and frontend communicating processors in the SNA/DDP period will continue over into the expert systems in specific areas. "Software" vendors will begin packaging ~~of~~ hardware/knowledge/ programs to satisfy specific human (expert) requirements. (An expert medical system is mechanized in the sense that it performs a single function--decision making in medical diagnosis.)

- Data base systems will tend to lose their identity in order to serve specific data/information/knowledge requirements of expert systems in the new operating system hardware/software/firmware environment.

- Languages and decision support systems will also have lost their identity except as generic classifications.

- Industry turnkey systems at the electronic office level will give way to turnkey networks with dependency upon data/information/knowledge sources.

o Public networks will contribute to and benefit from the data/information/knowledge bases that will be at the foundation of the Custom Products period, which will follow.

4. THE CUSTOM PRODUCTS PERIOD (2000 AND BEYOND)

o It would not be realistic at this point to forecast specific product and service opportunities (this would be rather like forecasting the computing environment of the 1970s in 1950). However, the broad outlines can be sketched.

o By the turn of the century, a high percentage of the population will be spending part of each day at an intelligent workstation. This will include not only current office workers, but an ever-growing number of people working from their homes on a part-time basis. Education and training will literally become a way of life in the 21st century, and in addition, workstations will become leisure stations, with a wide variety of interactive activities and entertainment available.

o While it is beyond the scope of this study to describe the "information age," it is important to recognize that almost everyone will both need and want the products and services available on public information networks. The potential, when viewed in this way, staggers the imagination--and so do IBM's size and revenue requirements. Whether IBM hits the $400 billion mark by the year 2000 may be questionable; but barring massive governmental intervention (either domestic or foreign), IBM will be the world's largest private enterprise, and as a factor in the world's economy its influence will be rivaled by few nations.

- The dependencies, challenges, and opportunities of the 21st century can be summarized in one world--software! Essentially, it will be software that:

  - Facilitates the replacement of current media for recording, communicating, and storing data with electronic data bases organized and structured to permit ready access to valid data on a timely basis for authorized users. These data will be a product when they are in the public domain because they will have value. The information age will be dependent upon these data bases.

  - Permits electronic information bases to become the libraries of the future. The challenge will be to replace books (which are frozen at a moment in time) with living documents that fully take advantage of the new technology--history can come alive in full color, and statistics can be illuminated with simulated (or real) games of chance.

- To say the least, this is a challenging picture, one that even ~~a $400 billion~~ 9 IBM will have difficulty dealing with unassisted, and one that IS must manage. The success of an enterprise will become more dependent upon the timely delivery of strategic information. The next 25 years will see the evaluation of data through information to knowledge and will produce the tools to get this knowledge to the proper people. IS's challenge is to orchestrate the delivery of ~~the~~ knowledge to the competitive advantage of the enterprise.

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EXHIBIT II-1

U-SAR

I.S. MUST UNDERSTAND STRATEGIC SOFTWARE PERIODS

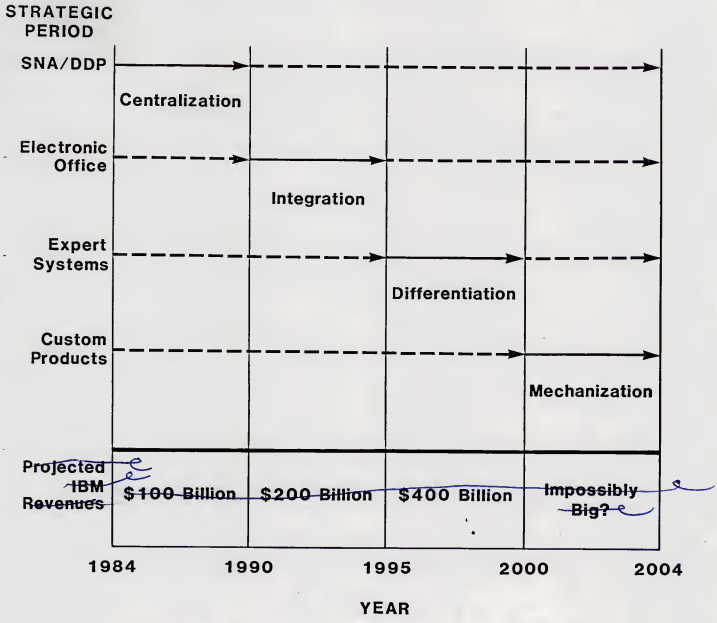


EXHIBIT II-2

THE CHANGING SOFTWARE FOCUS

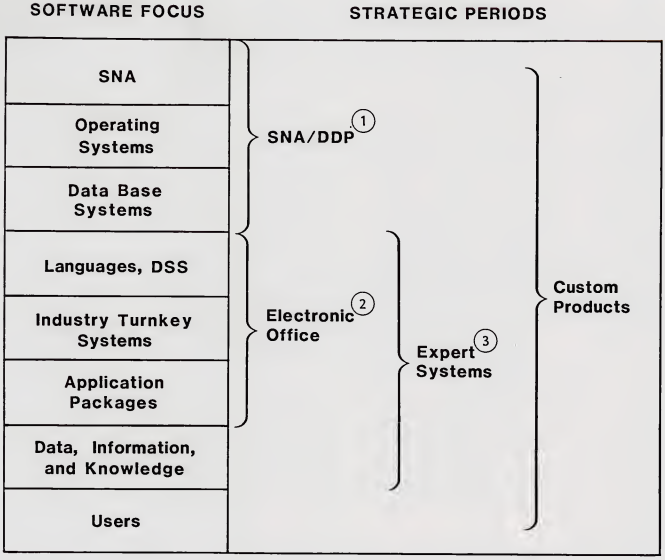


EXHIBIT II-3

IBM OPERATING SYSTEMS: CENTRALIZATION IS KEY

OPERATING SYSTEMS FUNCTIONS	INTEGRATION	DIFFERENTIATION	MECHANIZATION	CENTRALIZATION
Process	IBM	X		
Storage Management				X IBM
Protection & Security		X		IBM
Resource Allocation	X			IBM
System Structure			X	IBM

X = Predominant General Systems Trend

EXHIBIT II-4

IBM DEVIATES FROM PREDOMINANT SOFTWARE TRENDS

SOFTWARE AREA	INTEGRATION	DIFFERENTIATION	MECHANIZATION	CENTRALIZATION
Data Base Management Systems	IBM		X	
Languages/Decision Support Systems	IBM	X		
Industry Turnkey Systems	X IBM	IBM	X	IBM
Applications Packages	IBM	X		
Data/Information/Knowledge Bases		X		IBM

X = Predominant General Systems Trend

MAKE LARGE SYSTEMS MORE PRODUCTIVE

IBM Strategies:

- Magnetic Disk Revenue
- SNA Hierarchy
- Big Central Data Bases
- Big Central Engine
- Central Software

Technical Challenges:

- Optical Memories
- Minicomputers
- Entropy of Data
- MIPS on Schedule
- Performance Catastrophe
- UNIX Success

Implications

- Host Performance Management
- Process Distribution
- DBMS Differentiation & Mechanization
- Language/DSS Differentiation

PREPARE NOW FOR ELECTRONIC OFFICES

IBM Strategies:

- Revenue from Major Office Hardware Replacement
- Integrated LAN
- Optical Storage Media
- Turnkey Software
- Interoffice Communications

Technical Challenges:

- Competitive Software
- Network Management
- In-Place Alternative
- New IBM Operating Systems
- Sales Resistance

Implications

- ~~"Help" IBM with Industry Systems~~
- Communications-Oriented Operating Systems
- Early Expert Systems
- New Applications Required
- Knowledge Bases

EXPERT SYSTEMS ARE COMING

IBM Strategies:

- Revenue from Software & Services
- Network Management and Security
- Data/Information/Knowledge Bases
- Organization

Technical Challenges:

- Standardization (Network & D/I/K)
- Knowledge Base Availability (Acquisitions)
- Tariffs (Pricing)
- Regulation
- Management

Implications

- H/F/S Progressive Mechanization
- Knowledge Bases
- Expert Systems

EXHIBIT II-8

PREPARE FOR THE AGE OF INDIVIDUALIZED SYSTEMS

- Prepare for:
  - Hardware Implementation of Knowledge Bases
  - Software Implementation of Knowledge Bases
  - User Solution Orientation
- Use the Vendors to Help Derive Solutions
- Customize Systems to Users' Unique Needs

EXHIBIT IV-1

CONCEPTS OF GENERAL SYSTEMS THEORY (GST)

GST CONCEPT	HARDWARE EXAMPLE(s)	SYSTEMS SOFTWARE EXAMPLE(s)
Progressive Integration (Interdependence)	Networked Terminals	Multiprogramming/ Timesharing
Progressive Differentiation (Specialization)	Dedicated Processors (Development, Production, Data Base, etc.)	DBMSs, Procedural Languages, (PL/1, BASIC, FORTRAN, COBOL, etc.)
Progressive Mechanization (Automation of Function)	Minicomputers and Controllers	IMS, User Friendly Interfaces
Progressive Centralization (Control)	360/65 → 3084QX	VM, MVS/XA

EXHIBIT IV-2

IBM SOFTWARE PYRAMID

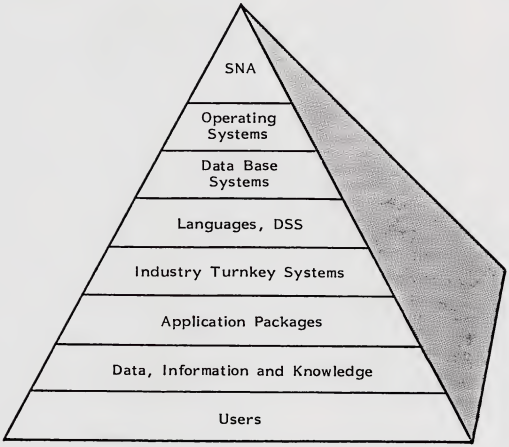


EXHIBIT IV-3

PREDOMINANT GST TRENDS IN OPERATING SYSTEMS
(MICRO-MAINFRAME PERSPECTIVE)

OPERATING SYSTEM AREA	PROGRESSIVE INTEGRATION	PROGRESSIVE DIFFERENTIATION	PROGRESSIVE MECHANIZATION	PROGRESSIVE CENTRALIZATION
Process		X		
Storage Management				X
Protection and Security		X		
Resource Allocation	X			
System Structure			X	
Hardware/ Firmware/ Software			X	

EXHIBIT IV-4

HIERARCHICAL NETWORK

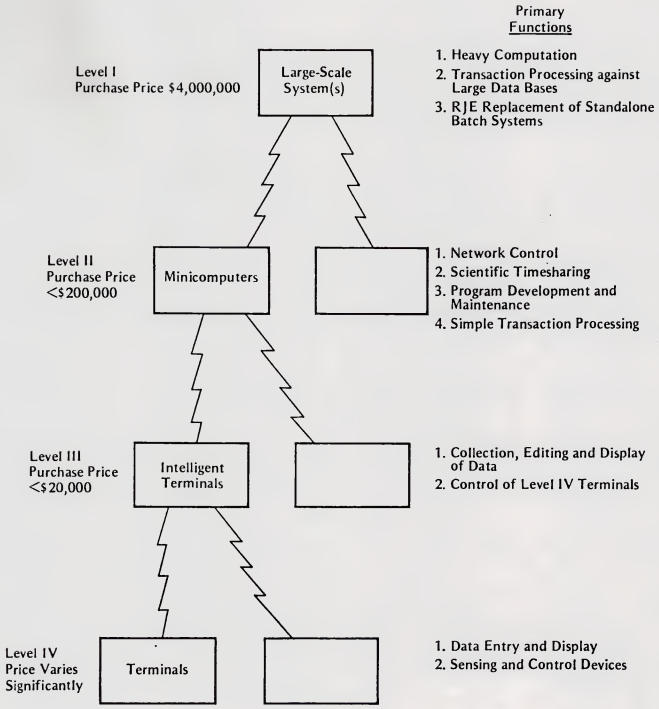


EXHIBIT IV-5

ARCHITECTURAL DISTRIBUTION OF PROCESSING, 1978

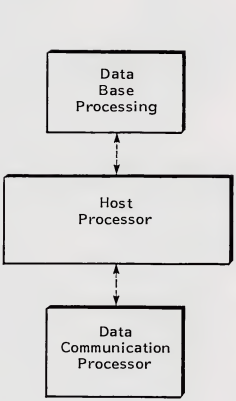


EXHIBIT IV-6

IBM OPERATIONS SYSTEMS DIRECTIONS
(Compared to Predominant GST Trends)

OPERATING SYSTEM AREA	INTEGRATION	DIFFERENTIATION	MECHANIZATION	CENTRALIZATION
Process	IBM	X		
Storage Management				X IBM
Protection and Security		X		IBM
Resource Allocation	X			IBM
Systems Structure			X	IBM
H/F/S			X	IBM

X = GST Predominant Trends from Exhibit IV-3

EXHIBIT IV-7

IBM's MICRO-MAINFRAME SOFTWARE DIRECTIONS

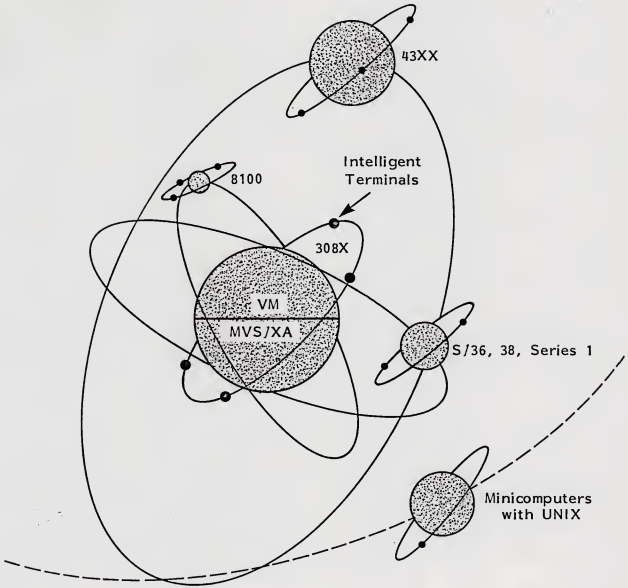


EXHIBIT IV-8

THE GREAT BLUE HOLE OF SYSTEMS SOFTWARE

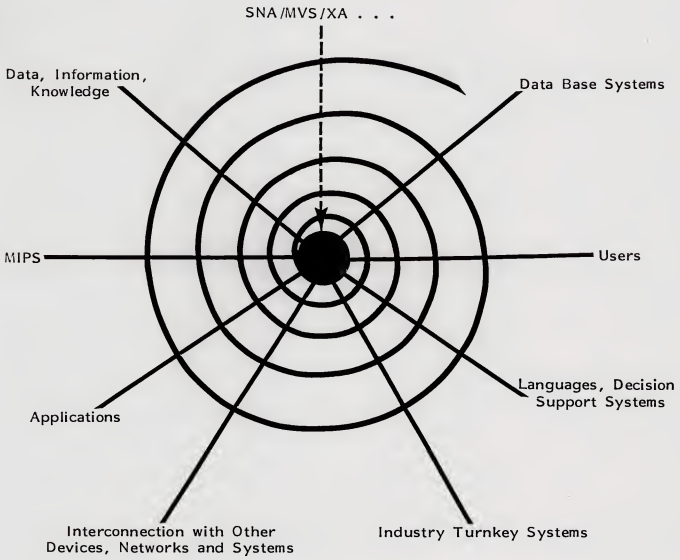


EXHIBIT IV-9

DB2 GENERAL ARCHITECTURE

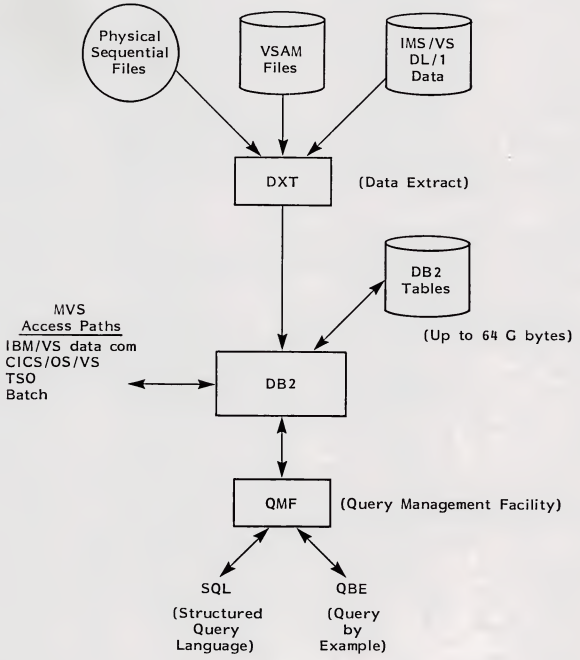


EXHIBIT IV-10

THE PROBABLE IBM DATA BASE OPERATIONS ENVIRONMENT

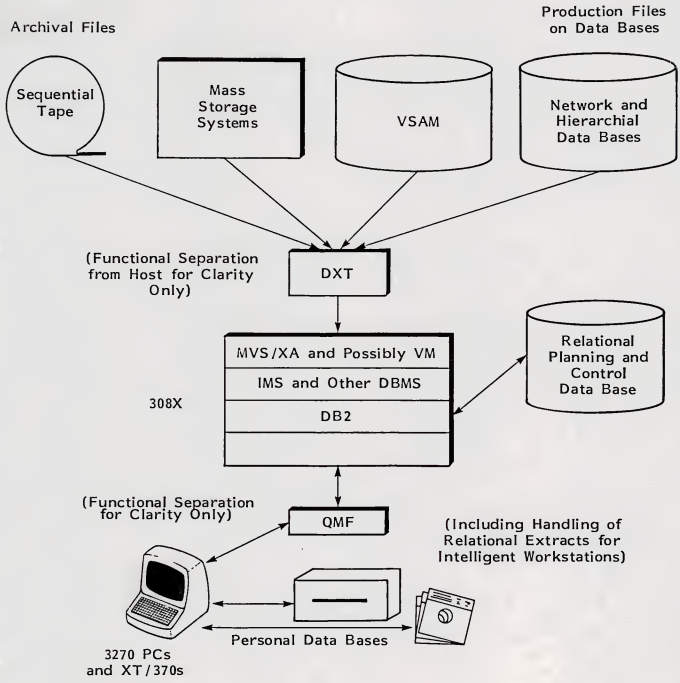


EXHIBIT IV-11

PROJECTED STRUCTURE OF DISTRIBUTED DATA BASES

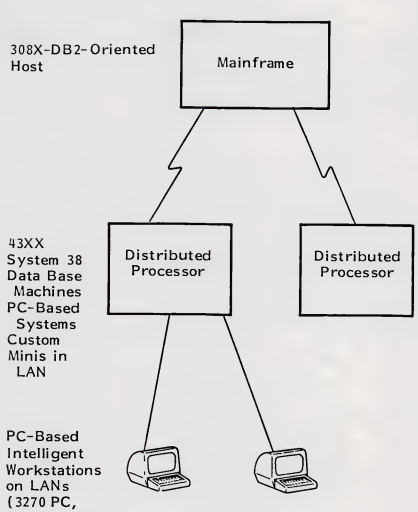
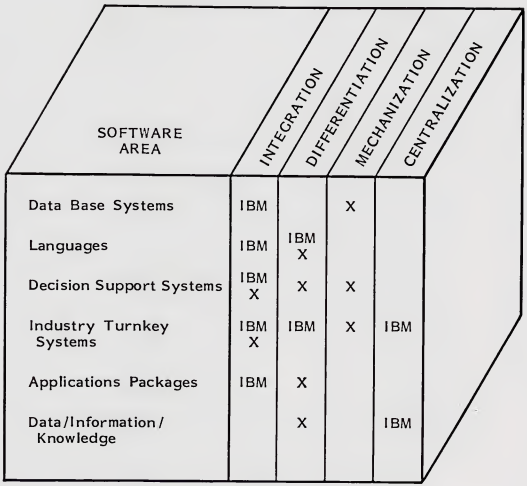


EXHIBIT IV-12

IBM SOFTWARE DIRECTIONS
(Compared to Predominant GST Trends)



SOFTWARE AREA	INTEGRATION	DIFFERENTIATION	MECHANIZATION	CENTRALIZATION
Data Base Systems	IBM		X	
Languages	IBM	IBM X		
Decision Support Systems	IBM X	X	X	
Industry Turnkey Systems	IBM X	IBM	X	IBM
Applications Packages	IBM	X		
Data/Information/ Knowledge		X		IBM

X = GST Predominant Trends from Exhibit IV-3

EXHIBIT V-1

CHARACTERISTICS OF STRATEGIC SOFTWARE PERIOD
(1984-2000 AND BEYOND)

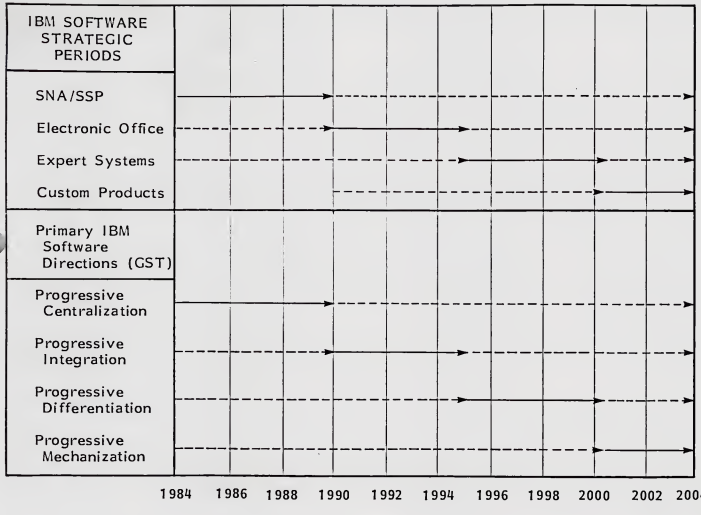


EXHIBIT V-2

SNA/DISTRIBUTED DATA PROCESSING PERIOD:
PROGRESSIVE CENTRALIZATION (1984-1989)

Key: IBM = Predominant IBM Direction
X = GST Direction

SOFTWARE AREAS	Integration	Differentiation	Mechanization	Centralization	IMPLICATIONS
Operating Systems Process	IBM	X			Off-Load Host Mainframe (Application)
Storage Management				IBM X	Efficient Storage Management at DASD Level
Protection and Secutity		X		IBM	Define and Address Problems Now
Resource Allocation	X			IBM	Performance Monitors
System Structure			X	IBM	Simplify Through Systems Design
Hardware/Firmware/Software			X	IBM	Data Base Machines, Network Managers, Performance Monitors
Data Base Management	IBM		X		Optical Memories, Information Management (New Models for Text, Graphics)
Languages, Decision Support Systems	IBM	X			Differentiate! Languages, Dictionaries
Industry Turnkey Systems	X IBM	IBM	X	IBM	Combination of Above
Application Packages	IBM	X			Design to Off-Load Mainframe, and with Industry/Professional Specialization
Data/Information/Knowledge		X		IBM	Anticipate and Understand Problems of Entropy & Data/Information/Knowledge

IBM DEPENDENCIES AND CHALLENGES

Dependencies:

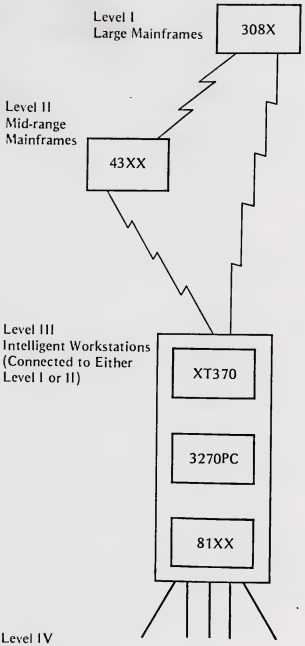
1. Magnetic Disk Storage Revenue
2. SNA Hierarchy
3. Big Central Data Bases
4. Big Central Engines
5. Central Software

Challenges:

1. Optical Memories
2. Minicomputer Success in Offloading
3. Entropy
4. Move MIPS on Schedule
5. Performance
6. UNIX Success

EXHIBIT V-3

IBM'S PROCESSING HIERARCHY



Primary Functions

Level I
1. Heavy Computation
2. Transaction Processing against Large Data Bases
3. Data Base Management for Network

Level II
1. Local Data Base Management (for LAN)
2. Growth Path to Level I (4381 MVS/XA)
3. Direct Replacement of Minicomputers — Including Scientific and Engineering Processing (4361)

Level III
1. Professional Workstation
2. Program Development and Maintenance
3. Transaction Processing against Personal Data Bases
4. Level I and II Compatible Processing
5. PC Standalone

1. Intelligent Workstations
2. Collection, Editing, and Display of Data
3. Processing against Multiple Local and Remote DBs
4. PC Standalone

1. Cluster Controller
2. Document Interchange
3. OA Interface

Level IV
Various Input, Output, and Sensing Devices

EXHIBIT V-4

ELECTRONIC OFFICE PROGRESSIVE INTEGRATION

(1990-1995)

Key: IBM = Predominant IBM Direction
X = GST Direction Systems

SOFTWARE AREA	Integration	Differentiation	Mechanization	Centralization	IMPLICATIONS
Operating Systems	IBM	X			Communications-Oriented Operating Systems
Data Base Management	IBM	X			Evolve Data Information Knowledge-Based Systems Move Rapidly
Languages, Decision Support Systems		IBM	X		Mechanize Down to Workstation Level Early Expert Systems
Industry Turnkey Systems		IBM X			Major Expansion
Applications Package	IBM	X			New Applications for Integrated Offices
Data/Information/ Knowledge	IBM	X			The Integrated Electronic Office Will Need Data/Information/Knowledge

IBM DEPENDENCIES AND CHALLENGES

Dependencies:

1. Revenue from Massive Hardware Replacement (Office Systems)
2. Integrated LAN
3. Optical Storage Media
4. Turnkey Software
5. Inter-Office Communications

Challenges:

1. Competitive Software
2. Network Management
3. In-Place Alternatives
4. New Operation System
5. Sales Resistance

EXHIBIT V-5

EXPERT SYSTEMS PROGRESSIVE DIFFERENTIATION

(1996-2000)

Key: IBM = Predominant IBM Direction
X = GST Direction

SOFTWARE AREA	Integration	Differentiation	Mechanization	Centralization	IMPLICATIONS
Operating Systems	IBM		X		Appropriate Hardware/Firmware/ Software Distribution
Data Base Systems		IBM	X		Data/Information/Knowledge Bases Will Dictate Hardware/Software/Firmware
Languages, Decision Support Systems		X	IBM		Continuation of Previous Period
Industry Turnkey Systems		IBM X			Emphasis Upon Networks and Data/
Applications Packages		IBM	X		Applications Including Data/Information/ Knowledge "Subscription"
Data Information and Knowledge	IBM	X			Public-Network-Oriented Data/ Information/Knowledge as Required

IBM DEPENDENCIES AND CHALLENGES

Dependencies:

1. Revenue from Software and Services
2. Network Management (Including Security)
3. Data/Information/Knowledge Bases
4. Organization

Challenges:

1. Standardization
2. Data/Information/Knowledge Availability
3. Tariffs (Pricing)
4. Regulation
5. Management